ROADS AND STREETS

PUBLISHED MONTHLY BY ENGINEERING AND CONTRACTING PUBLISHING COMPANY
221 EAST 20TH STREET, CHICAGO

HALBERT P. GILLETTE, President and Editor
C. E. BREGENZER, General Manager
New York Office, 441 Lexington Avenue: ERWIN T. EYLER, Eastern Manager

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $2.00 a year.

Roads and Streets—1st Wednesday
Water Works—2nd Wednesday
General Contracting—3rd Wednesday
Buildings—4th Wednesday

All four may be subscribed for at the special rate of $5.00 a year, and thus taken they provide a weekly service completely covering the construction field.

Foreign Postage 65c extra for each magazine

Copyright, 1926, by Engineering and Contracting Publishing Company

Vol. LXV CHICAGO, FEBRUARY 3, 1926 No. 2

Overhead Footways for Busy Places

There are locations in every great city where small expenditures for elevated walks across streets would add to the safety and comfort of pedestrians and to the relief of roadway congestion. The greatest opportunities of this character are generally at railway terminals having heavy suburban traffic. Such improvements do not have to be one hundred per cent effective. Take a large part of the night and morning rush off the street at these places and you have made a worthwhile accomplishment.

Our traffic problems are becoming more and more clearly seen as complications of so many conflicting requirements that the solution lies in the skillful use of many expedients rather than in any single, comprehensive stroke. The expedient of the elevated footway is not new but is neglected. Proposals for extensive elevated walks in congested areas are being more and more urged in various cities, with the probability that some such systems will be built in the near future. Without doubt they will be successful, but as they require costly remodeling and rearrangement of building fronts, their introduction will be necessarily slow.

The overhead footway at strategic points will generally be short, with one or more street crossings as it primary object, and only enough additional length to serve this purpose practically. The cost of the structure will be small and the cost to abutting property will be nil in most cases.

The practicability of the elevated walk depends on several factors. One thing, it must be recognized that the walking public avoids ups and downs, as a consequence of which pedestrian grade separations sometimes have failed to be of any considerable use. An arrangement which merely takes people up a flight of steps, across a street, and down another flight will not count for much; but where one end of a route is elevated, so that little or no extra climbing is involved, there is often a fine opportunity.

Elevated railway stations, wherever possible should be connected with the sidewalks on both sides of each street which passes beneath. There is seldom a good excuse for an arrangement requiring a passenger to cross a street immediately after descending from an "L" station. The tracks of many railway terminals are either elevated or depressed, and might well be connected with footways at the same level to take passengers across adjacent streets. Such means are especially important in the service of suburban traffic.

Cities of steep hills sometimes afford special opportunities for elevated walks. Seattle, for example, has long had a walk in Marion St. leaving the sidewalk grade at First Ave. and extending westerly across Western Ave. and a group of railroad tracks to the Coleman Dock, where most of the local passenger steamers land. Prior to the installation of this improvement the tracks all had to be crossed at grade.

The ever increasing burden of traffic requires that we use our wits and our powers more fully in taking advantage of opportunities such as lie in overhead footways.

Born, June 11, 1874

Lewis S. Louer

Died, January 9, 1926

Words are but futile things when it comes to expressing one's sorrow over the passing of a beloved friend, a tried and true business associate, a loyal friendly man. Lewis S. Louer is dead. He died suddenly in the early morning of January 9, of heart failure. He had been at his office the previous day, well and in the best of spirits.

Lewis S. Louer was born, June 11, 1874, in New Castle, Pa., and was graduated from the Mechanical Engineering Department of Cornell University in 1894. On September 25, 1906, he was married to Miss Elsie Macomber of Des Moines, Iowa, who with a daughter, LaVerne, survive him. The daughter is now in Paris taking a post graduate course at the Sorbonne.

Practically all Mr. Louer's business life was devoted to the technical publishing industry. Immediately after leaving college he became connected with the Buffalo Forge Company of Buffalo, N. Y. He was with this company only a short time, and then became associated with Cassiers Magazine, as an advertising solicitor. For the last 24 years he has been engaged in the publishing business in Chicago, first as Western Manager of the Engineering Record, later with the F. W. Dodge Company as Western Manager, and for the past 8 years as Vice-President of the Engineering and Contracting Publishing Company.

Mr. Louer was a director of the American Road Builders Association and was chairman of the registration committee for the 1926 Convention and Road Show. Until recently he was a member of the Union League Club, of Chicago, and of the Midlothian Country Club. At the time of his death he was a member of the University Club, the Exmoor Country Club, the Racquet Club and the Saddle and Cycle Club.

Mr. Louer's charming personality had won him a very wide circle of friends not only in Chicago but throughout the Mississippi Valley and the Atlantic States.

Lewis S. Louer

The untimely death of Lewis S. Louer is the second tragedy in the 20 year history of this publishing house. He and Myron C. Clark, his predecessor, were alike in the fineness of their natures and in the wonderful regard that they inspired in all who knew them well.

The outstanding feature of their characters was kindness. I can still see Myron Clark raising his hat to "the little apple lady" as he paused before her stand each evening to make his daily purchase of the apple a day that, alas, failed at last to keep the doctor away. And precisely the same sort of recollections will come to me, many and many a time, of the same chivalrous instinct of Lewis Louer, pictures of the kindliest courtesy in even the smallest transactions.

As I write, a letter comes to me saying: "Mr. Louer was a most lovable man and I was very fond of him." This simple, graceful tribute typifies in its spirit many another message that has been received.

As a youth I used to hear it said that if you really wished to know a boy you should go camping with him for a few weeks; and I found that there was sound advice in that suggestion. For eight years I "camped" with Lewis Louer, and I learned that what on first acquaintance he appeared to be, that he actually was. There was no pretense of good will, put on for effect, but a natural upwelling of good will. He liked people, and he liked to show his liking. He was interested in others, and he showed his interest.

The other day one of his friends told me a little incident that is better than any generalization. He said that he had lost his job and wrote to Lewis Louer asking him for assistance in securing another job by sending a letter of recommendation to a certain firm. "Do you want to know the sort of letter Lewis sent? He mailed it on the next train by special delivery, and he himself was both the deliverer and the letter."

In his inimitable way Elbert Hubbard told the story of The Message to Garcia, a story of a very difficult task performed without any instructions except to find Garcia (fighting somewhere in Cuba), and to deliver a message. Bravery, determination and resourcefulness were required in the execution of the task. But the world war has taught us that the qualities that make heroes are not rare. There are rarer qualities than courage, qualities not less worthy of praise and emulation. Kindly considerateness deserves, I believe, to be classed with courage. At any rate it is a rarer quality, especially in men. In the hurly burly scramble of business life its rareness is most noticeable. For this reason men like Lewis Louer and Myron Clark will always be vivid in our memories.

Extreme kindliness of nature is always followed by a train of other admirable attributes —sincerity, fairness, charitableness, generosity. They are all of one princely family.

Last summer Lewis Louer went to Europe, and upon his return told of experiences unlike those of the ordinary traveler. Usually one hears much of the exorbitant charges that tourists are forced to pay, the acres of itching palms, nights made hideous by noise, days made dreary by endless marches through galleries, cathedrals and avenues of tombs. Louer returned effervescent with delight. The French were the finest of hosts, moderate in their charges, supreme in their cookery, delightful to know. An incident will tell all: Walking in a vineyard region Louer stopped at a cottage to buy some grapes. In payment he offered the old farmer a sum that he could not be induced to accept for so small a service. Having returned the change, the farmer insisted upon standing treat, bringing forth a tumbler of his choicest vintage. "No," said Louer to me, "I do not believe the stories I hear of French cupidity. They are a fine, generous people, generous even when stricken with poverty."

As I listened I wondered whether we do not often see in other people visions of our inner self. Are we critical? Then a critic looks back at us from almost every pair of eyes. Are we fault-finders? Then each person we talk with is apt to talk complainingly. But if, like the boarder in The Passing of the Third Floor Back, we are sympathetic, the best of qualities greet us even among strangers.

On another page is printed a recent photograph of Lewis Louer and a brief summary of his career. It was a most useful and an exceptionally happy career. He enjoyed life to the full. His enjoyment was widely radiated, and in return his heart was warmed by the glow of many fine friendships.

True friend, we can all say, here part our earthly destinies. Now friendship's grief must be assuaged by friendship's memories.

HALBERT P. GILLETTE.

Effect of Weather Conditions on Bids

Some interesting information on the above subject is given by Rome A. Schaffner of Siems, Helmers & Schaffner, St. Paul, Minn., in a recent issue of The Constructor, from which we quote as follows:

"When a great many of our present day contractors figure a job they give little heed to the question of weather conditions. From my experience, I find that good and bad days average up fairly well. The expression that 'it was wet last year so it will be dry this year' has had a great deal to do with the disastrous results of a great many contracts.

"Our practice on all jobs is to require a daily report to be sent to the head office each day and on that report is shown weather conditions, and in the event another contract is figured in approximately the same territory, we have some idea of the actual number of working days in the season. In figuring a new piece of work in a strange section of the country, we endeavor to get a line on the weather conditions, and particularly with regard to the annual rainfall. This information can be obtained from the United States Government for a term of years and if the average of five years is used, I do not believe you will be very far wrong.

"I well remember several years ago when contracting in Iowa the difficulties we had with wet grades and when some additional work came up in the same territory the following year, we took these conditions into consideration and, of course, did not get the work, but we made more money than the contractors that were successful in securing the jobs, as in this case history repeated itself and it was necessary to bed the dump-cars with straw in order to clear them on the dump.

"There is a great deal of difference between contractors in handling work under all weather conditions. Some contractors give a great deal of thought to drainage and to reserving some of their best work for wet days, and in this way overcome some of the difficulties, but in the long run, there is only one safe way and that is to be sure that you are not planning your outfit on a calendar basis but on a working day basis."

Causes of Highway Accidents

Statistics of highway accidents involving motor vehicles, compiled from newspaper reports of accidents in the states of Montana, Oregon and Washington by the Bureau of Public Roads of the U. S. Department of Agriculture, show that Montana with the lowest registration has the smallest number of accidents per 1,000 cars, while Washington with the largest registration has the most accidents per 1,000 cars. During a period of 8 months, newspaper reports of 1,606 accidents in the three states secured, and the causes of accidents classified as follows:

Faulty operation by driver	1020
Faults of others than drivers	191
Faulty equipment	181
Faulty highway conditions	214

The detailed statement of the causes of accidents shows that 711, or more than 40 per cent of the total per cent of the total, were caused by reckless or careless driving. Of the 214 accidents caused by faulty highway conditions, 19 were caused by narrow roadways and 150 by skiddy surfaces.

Road and Street Contracts Awarded During the Last 71 Months

The accompanying table, compiled from statistics in the Engineering News Record, shows three outstanding facts: First, that highway contracts awarded during the last half of each year have averaged only 25 per cent less in volume than those awarded during the first half; second, that there is not a month in the year without a very large volume of road and street contracts awarded; third, that each year shows a substantial gain over its predecessor.

ROAD AND STREET CONTRACTS EXCEEDING $25,000 IN SIZE

	1920	1921	1922	1923	1924	1925
January	$ 12,204,000	$ 11,598,000	$ 14,424,000	$ 21,691,000	$ 16,972,000	$ 22,720,000
February	21,334,000	12,049,000	9,052,000	18,781,000	19,214,000	20,104,000
March	26,221,000	25,880,000	39,669,000	37,706,000	41,395,000	25,910,000
April	33,340,000	31,026,000	32,991,000	29,641,000	43,513,000	60,801,000
May	30,258,000	35,064,000	42,284,000	46,528,000	65,354,000	53,418,000
June	31,441,000	56,777,000	42,138,000	38,040,000	44,494,000	42,451,000
July	29,353,000	33,943,000	26,087,000	42,397,000	45,784,000	45,246,000
August	18,565,000	28,693,000	37,035,000	35,639,000	40,536,000	41,199,000
September	26,537,000	23,257,000	28,884,000	37,812,000	44,585,000	36,949,000
October	12,894,000	20,055,000	23,162,000	28,144,000	35,198,000	31,416,000
November	12,443,000	20,751,000	20,892,000	23,683,000	18,382,000	23,492,000
December	10,834,000	16,263,000	18,096,000	21,035,000	14,894,000	----------
Total	$265,424,000	$315,356,000	$334,741,000	$381,097,000	$430,231,000	----------

Note.—About 100 per cent must be added to these totals to give the grand total of highway contracts in the United States.

Bridges are not included, and bridge contracts average 15 per cent as much in value as road and street contracts. A great deal of road and street work is done by directly hired labor and is not included above.

Concrete Paving Practice

Recent Developments Outlined in Paper Presented Jan. 14 at 23rd Annual Convention of American Road Builders Association

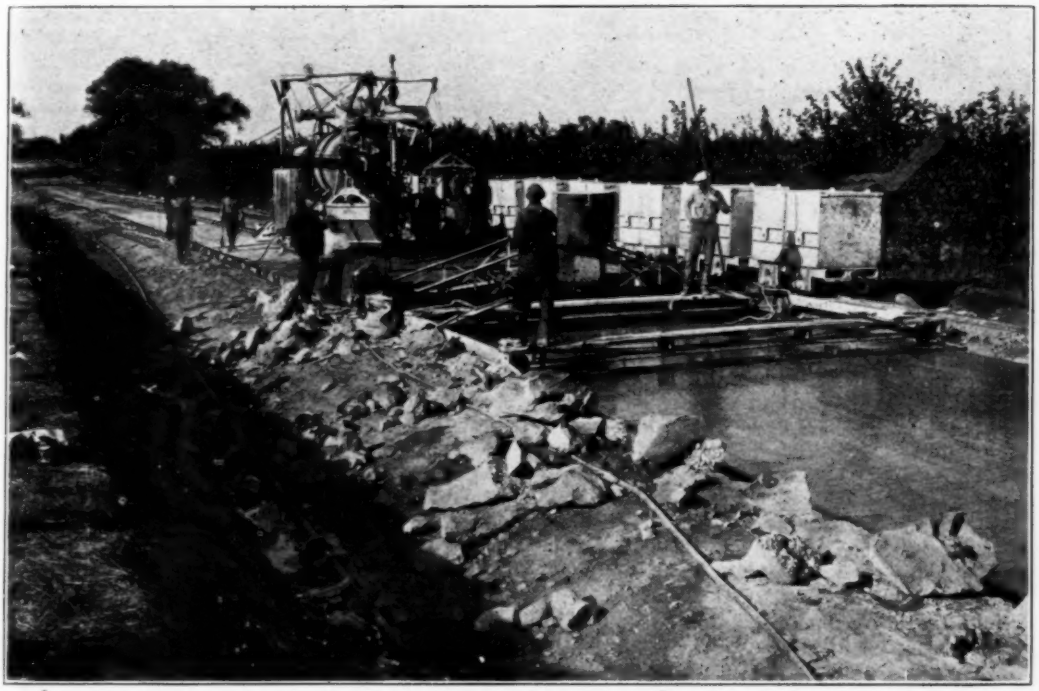
By H. E. SURMAN
Engineer of Design, State Division of Highways of Illinois

One of the most important developments is the improvement in highway alignment. While a few years ago most of the states were satisfied to adhere quite closely to existing highways, relocations have become the order of the day, and we no longer hesitate in opening up entirely new rights of way for the purpose of saving distance between important centers, cutting down constructions, operating, and maintenance costs, and avoiding grade crossings with railroads.

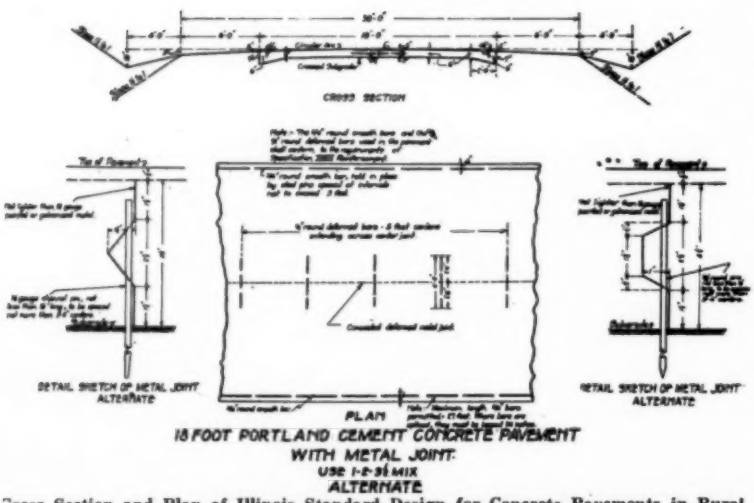
Where a few years ago right angled turns were rounded by means of a 100 or 200 ft. radius curve and practically no super-elevation was used, today the modern highway is built with a minimum 500 ft. radius curve for right angled turns with correspondingly longer curves for smaller angles, and adequate super-elevation provided for all curves up to 5,000 or 6,000 ft. radius. The essential thing is to provide an alignment that will permit traffic to move at the legal speed limit with reasonable safety.

Shoulders and Side Ditches.—Earth shoulders are now built of sufficient width to permit a vehicle to park along the side of the pavement without interfering in any way with traffic. This is a very essential feature of road design and construction and is an item which is not considered seriously enough by many of the states. The minimum shoulder width for country districts should be 6 ft., and near large centers of population, it should be 8 ft.

The development of the shallow side ditch, wherever practical is an important safety feature. The practice in Illinois is to construct a 4 to 1 slope from the edge of the shoulder to the bottom of the ditch, with the ditch only



Construction View of State Highway Near Aurora, Ill.; Chicago Heights Construction Co., Contractors



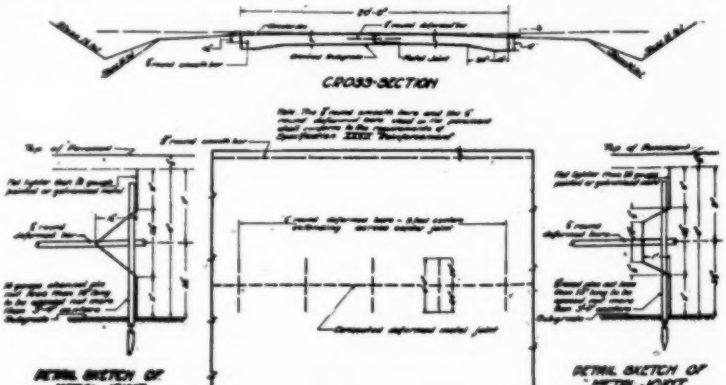
Cross Section and Plan of Illinois Standard Design for Concrete Pavements in Rural Districts and Near Small Centers of Small Population

12 in. below the shoulder elevation. This practice could not, of course, be carried out in cases where deep ditches are required for larger quantities of water. This might also prove detrimental in some of the northern states because of the snow removal problem but wherever it can be applied without detriment to the drainage of the road, it will certainly help promote the safety of the highway.

Standard Cross Section.—One of the most outstanding and far reaching developments in concrete paving design is the standard cross section developed from the Bates Road tests, conducted by the Illinois Highway Department during the years 1920 to 1923, inclusive. The main features of this design are the thickened edge with longitudinal steel bars near each outer edge, and a longitudinal dividing plane in the center of the pavement with transverse dowel bars. More than thirty of the states are now either using this design or some modification of it.

A more recent development of this design is the application of a heavier or thicker pavement near large centers of population. The Illinois practice is to use a 6 in. central thickness with a 9-in. edge thickness for traffic near small cities and rural districts, and a 7 in. central thickness and a corresponding increase in edge design for traffic near large centers of population. Pavements near the larger centers also are built to a width of 20 ft. for the initial construction unit, whereas the downstate pavements for the more rural districts are mainly 18 ft. in width. The edge design for the 7 in. center thickness pavement is computed to give a corresponding increase in strength as compared to the edge design used with the 6 in. center thickness pavement. This heavier type of design is not used for the purpose of permitting heavier loads to travel the highway, but as a safety guard for the fatigue in the concrete due to a greater frequency of maximum loads. Approximately 3,000 miles of concrete pavements have been built in Illinois on the basis of the thickened edge and longitudinal center joint design.

Super Highways.—One of the most recent developments in highway design is the so-called super highway where eight or more traffic lanes are provided for on the same right of way. This would seem to be the proper solution of the congestion problem in cases where parallel routes designed to relieve such congestion are already improved. To make the plan successful, however, it is neces-

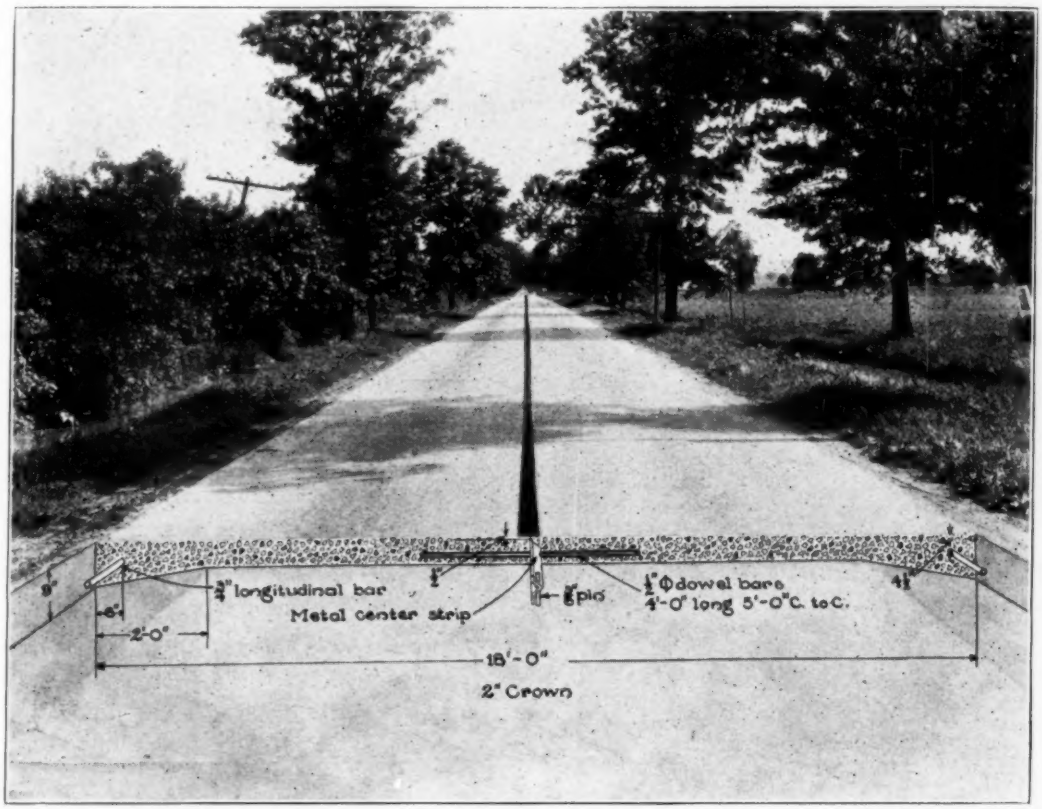


Cross Section and Plan of Illinois Standard Design for Concrete Pavement Near Large Centers of Population

sary that adequate provision be made to take care of traffic all the way to the heart of the metropolitan area which produces the major portion of the traffic, and unless this is done, the object of the super-highway will be defeated.

Another important development which is just in its infancy is the matter of widening and strengthening existing pavement. This is the natural outgrowth of traffic increases on the more important routes, and the years to come undoubtedly will witness the widening of many

ing or finishing machine, belts, 10 ft. straight-edge and long-handled float. The use of the long handled float and 10 ft. straight-edge to remove the surplus water and laitance from the surface of the pavement have been largely instrumental in eliminating the scaling action that was so common in concrete road construction up to a year ago. Diligent application of the above mechanical equipment and tools has eliminated almost entirely the scaling action on the surface of concrete pavements placed in Illinois during the past year. The surface



Completed Illinois State Trunk Highway Showing Center Traffic Strip and Cross Section of Illinois Standard Design

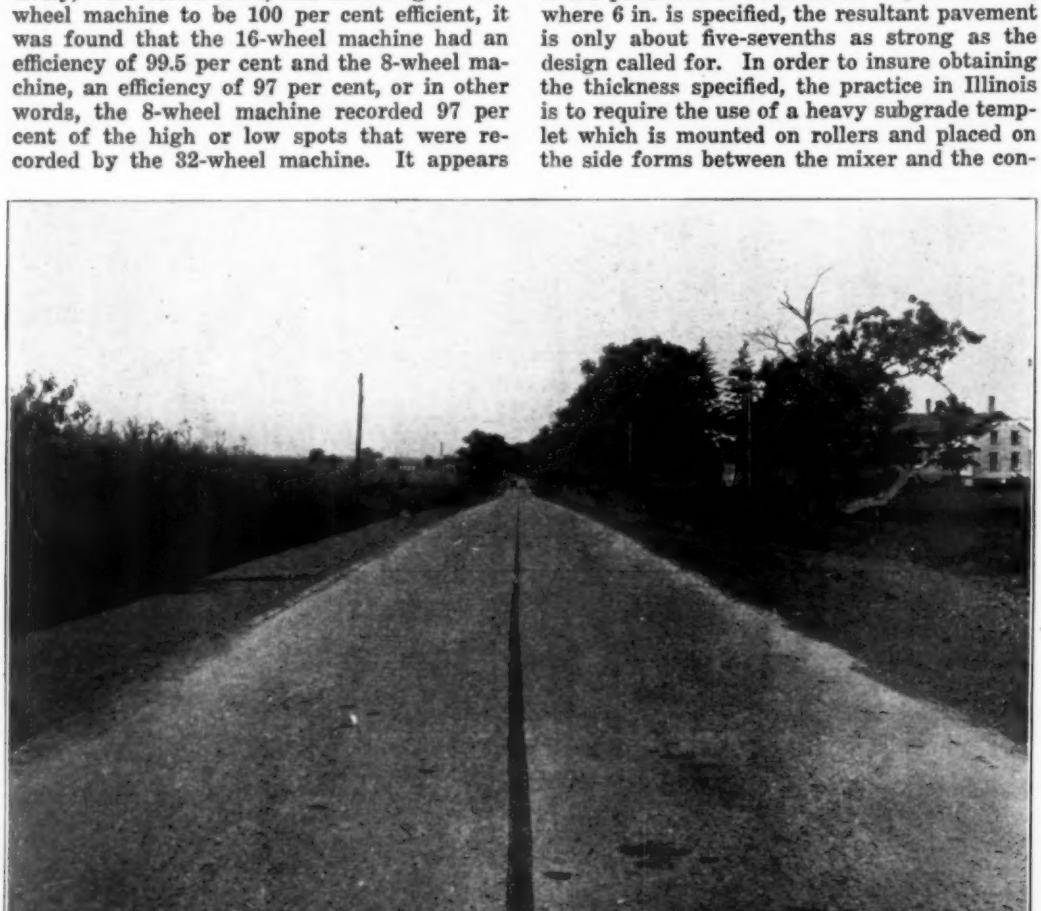
miles of pavement that are no longer of adequate width to care for the traffic which comes upon them.

Pavement Finishing.—The public is continually demanding smoother pavements and too much emphasis cannot be placed on this important feature of concrete paving practice, because the quality of the pavement is often judged by the smoothness of its surface. The methods described in specifications for obtaining smoothness varies considerably among the different states. In Illinois very good results have been obtained by the use of the compact-

is checked for smoothness with a 10 ft. straight-edge both before and after the concrete takes its initial set, and all variations exceeding ¼ in. are at once eliminated.

Method for Testing Smoothness.—A very good method for testing smoothness after the concrete has attained its initial set is by means of a machine known as the profilometer. This is a very simple machine constructed preferably of a number of rubber tired bicycle wheels with a device for recording the contour of the pavement as the machine moves over the surface. A number of different profilometers have

been constructed by the Illinois Highway Department, and tests were made of the various machines to determine their efficiency. Profilometers having 32, 16 and 8 wheels, respectively, were constructed, and assuming the 32-wheel machine to be 100 per cent efficient, it was found that the 16-wheel machine had an efficiency of 99.5 per cent and the 8-wheel machine, an efficiency of 97 per cent, or in other words, the 8-wheel machine recorded 97 per cent of the high or low spots that were recorded by the 32-wheel machine. It appears therefore that the 8-wheel machine is accurate enough for all practical purposes, and has the advantage of being easier to handle in the field. The profilometer, besides being a good detector of rough spots in the pavement, is a valuable machine in that it furnished an accurate graph of the surface of the pavement which can be used in future investigational work.



Illinois Bond Issue Road Near Woodstock, Ill., Showing Shoulders Wide Enough to Permit Parking Without Interfering With Traffic

Securing Specified Thickness.—The question of obtaining the specified thickness for the concrete pavement is one of prime importance, but it is only very recently that engineers have taken the proper precautions to insure that the thickness specified is actually obtained in the finished work. The strength of the pavement slab varies as the square of the thickness, and if the pavement is constructed only 5 in. thick, where 6 in. is specified, the resultant pavement is only about five-sevenths as strong as the design called for. In order to insure obtaining the thickness specified, the practice in Illinois is to require the use of a heavy subgrade templet which is mounted on rollers and placed on the side forms between the mixer and the concrete. Thus the subgrade is checked after the mixer has traveled over the same, and immediately before the concrete is placed. In addition to this, the resident engineer is required to take not less than three cross sectional readings on the subgrade each day and again on the finished pavement just after it has taken the final set. A final check consists of drilling cores and determining the actual thickness. Every effort is made to help the contractor to secure the minimum thickness specified as the work progresses, and it might be stated that since this method has been in prac-

tice, there have been exceptionally few cases of shortage in thickness.

Important considerations involving the quantity and quality of the resulting concrete are: checking daily the amount of cement used, and number of batches of concrete required per unit of length study of yield of concrete by suitable field determinations; automatic methods of measurement to secure uniformity of batches; automatic locking and timing devices to secure uniform mix; automatic water control to secure uniform consistency; and a tendency toward standardization of concrete mixers.

Use of Calcium Chloride.—Another important development is the use of calcium chloride as a curing agent. This probably has been used in Illinois more than in any other state, not less than 2,000 miles of concrete paving having been cured by this method. Calcium chloride is applied in flaked or granulated form and spread uniformly over the surface of the pavement by squeegees or suitable mechanical device at a rate of about 2½ lbs. per sq. yd. of pavement. The main advantages are the saving of labor and the fact that concrete so cured attains a greater strength in its early stages.

Use of Aluminate Cement.—The use of aluminate cement for paving short gaps and particularly for patches in maintenance work is becoming more popular. This enables the pavement to be opened within 24 hours after the concrete is placed and while the cost in small quantities is considerably more than that of Portland cement, it is justified from the standpoint of better service given the traveling public and the avoidance of lengthy detours.

Traffic Lines.—One of the most important recent developments and one which adds greatly to the safety of the highway is the use of the traffic line. This was the outgrowth of the longitudinal center joint design for concrete pavements, although it is now used with equal success on other types of pavements. The center traffic line is now in use by most of the states and in the writer's opinion, has done more to avoid accidents on highways than any other one factor.

What might be mentioned as essential in concrete paving practice is the care being taken by the states to analyze the contractor's ability both financially and as to performance of work before awarding a contract. This involves the study of financial statements, the past performance of the contractor, equipment for performance of the work, and the contractor's detailed plan and schedule for handling the work.

Strength Tests of Concrete.—During the past two years the transverse test for determining the strength of concrete has gained favor rapidly. This gives less variation in results than compressive tests on cores drilled from concrete pavements and has the added advantage of more nearly resembling the stress in concrete under actual traffic. Tests were made on 200 test beams, each 6x8x30 in., enough concrete being made in one batch to cast two beams at one time. Both transverse and compressive tests were made on each specimen. By means of the cantilever testing apparatus, two transverse tests were made on each beam. From each of the three remaining sections of each broken specimen cores were drilled by a calyx drill so that by this method two flexural and three compressive stresses were recorded for each specimen. Tests were made at 14, 28 and 90-day ages. The results show that the average difference in the compressive tests amounted to 72 per cent, while the average difference in the transverse tests was only 3.7 per cent. Additional investigations should be made on this subject before reaching a definite conclusion.

Highway Research.—It would not be fair to close a discussion on this subject without referring to highway research. Great forward strides are being made in this phase of highway work and while much has been determined during the past few years, there are still important problems before us. Such questions as stresses set up in the pavement slab under different temperature and weather conditions and the behavior of different sub-soils have by no means been definitely solved. There are many other important questions regarding paving design and construction which will require the diligent efforts of all research agencies for some years to come. It is a very interesting and fruitful field and one which really has no ending.

Civil Service Jobs with U. S. Bureau of Public Roads.—The U. S. Civil Service Commission, Washington, D. C., has announced open competitive examinations for the positions of chief engineering inspector-superintendent at an entrance salary of $2,400 and principal engineering inspector-superintendent at an entrance salary of $2,100. The examinations are to fill vacancies in the Bureau of Public Roads, Department of Agriculture, for duty in Washington, Oregon, Idaho, or Montana, and in positions requiring similar qualifications. After the probational period of six months required by the civil service act and rules, advancement in pay may be made without change in assignment up to $3,000 a year for chief engineering inspector-superintendent, and up to $2,700 a year for principal engineering inspector-superintendent.

Soil Tests

Methods for Field Determination Described in California Highways

By C. S. POPE
Construction Engineer, California Highway Commission

From time to time it is desirable for resident engineers to be able to determine whether or not soils which are available for paving foundations are suitable for the purpose. The following rather simple tests have been in use for some time and are considered reliable for the determination of adverse soils.

The lineal shrinkage test, which was first used many years ago on work in Los Angeles, still holds a valuable place in determining the qualities of soil which may render them unfit for foundations, while the method of determining the moisture equivalent, as developed by Mr. Rose of the Bureau of Public Roads and first used extensively on road work by Mr. McKesson, replaces the more cumbersome laboratory methods heretofore in use.

A description of the two tests follows.

Moisture Equivalent.—Except in cases of doubt, it is not always necessary to submit soil samples to the laboratory. A common method of testing the acceptability of a soil is to determine the so-called moisture equivalent percentage or, in other words, its propensity for holding water. The following field method will be sufficiently accurate to indicate the quality of subgrade materials in this respect, or for supplying the data for division engineers' preliminary reports.

Thoroughly air-dry and pulverize a 500-gram (or if more convenient, a 20-ounce) sample of soil to be tested. Remove all pebbles larger than ⅛ of an inch, then slowly and uniformly wet the sample to the point of saturation, that is, until the addition of any more water would cause the same to remain unabsorbed on the surface of the mass. It is imperative that this point be carefully determined as much will depend on the investigator's judgment.

The final consistency of the mixture should be about equal to that of putty and such that it can be easily kneaded and compacted with a spoon or spatula. Next carefully weigh the sample. The moisture equivalent percentage is the difference between the wet and dry weights of the sample computed as a percentage of the dry weight.

In general, when the moisture equivalent percentage is less than 20 per cent, the soil is satisfactory for subgrade. When between 20 and 30 per cent, the soil is only fair for subgrade and when it exceeds 30 per cent, the soil will make poor subgrade and some form of treatment probably will be necessary. When the resident engineer obtains results of 20 per cent or over, he should report to the division engineer for advice.

The necessary equipment is as follows. 1 agate basin; 1 100 c. c. burette; 1 pair suitable scales; and 1 spoon or spatula for mixing.

Lineal Shrinkage.—Soils which shrink or swell under varying water content, thereby causing displacement of the subgrade, are a detriment to the life of a road surface. Resident engineers are cautioned to be ever on the alert for the appearance of such soils. Their presence in the work very probably would nullify much of the extreme care taken later with the road surface and cause its early disintegration.

The following field method of determining the percentage of lineal shrinkage of soils will be sufficiently accurate to indicate the quality of materials in the subgrade:

Slowly and uniformly wet a sample of soil weighing about twelve ounces to the point of extreme saturation, as in the previous test. The final consistency of the mixture should be such that it can be easily kneaded and compacted. Pack as much of the sample as is needed with a wooden tamper in ½-in. layers in a galvanized iron or oiled wood mould, approximately 1 in. by 1 in. in cross section and either exactly 10 in. or else 12½ in. in length. The mould may vary from 1 in. by 1 in. to other satisfactory dimensions, but a length of either 10 or 12½ in. is recommended since a 10-in. length will give 1 per cent on a 1/10 scale and a 12½-in. will give 1 per cent for each ⅛-in. on a foot rule. Push the sample free of the mould on to any flat smooth surface. After drying the specimen thoroughly, carefully measure the length.

The drying should be done on a bed of dry sawdust or similar material to prevent warp. The specimen should also be turned over from time to time to secure uniform drying on all sides. The lineal shrinkage percentage is the difference between the wet and dry lengths of the specimen computed as a percentage of the wet length.

Usually, it is desirable to cast two or three test bars from each sample of soil for check purposes.

When the lineal shrinkage percentage is greater than 5 per cent (which corresponds approximately to a moisture equivalent of 30), special precautions should be taken to insure the road surface against failure due to movement of the subgrade. When such results are obtained, the resident engineer should report immediately to the division engineer for advice.

The necessary equipment is as follows:

One galvanized iron or oiled wood 1 in. by 1 in. by 12½ in. mould (open two sides); and one carpenter's foot rule.

Surface Treatment of Gravel Roads with Asphaltic Oils

Method and Costs in Caddo Parish, Louisiana, Described in Paper Presented October 22 at Fourth Annual Asphalt Paving Conference

By J. T. BULLEN
Parish Engineer, Caddo Parish, Louisiana

In Caddo Parish, Louisiana, we have been building gravel and macadam roads since 1912. By gravel I mean a sand clay gravel composed of from 50 to 70 per cent water worn pebbles combined with 30 per cent to 50 per cent of clay and sand, with the sand predominating to some extent. The sand should have some coarse grains and the clay have good binding qualities. Our seasons are 9 months summer and 3 months of winter. Average winter temperature is about 45° and average summer temperature is 83°, though the temperature frequently goes down to 16° in winter and stays above 90° for days at a time in summer and frequently stays around 95° to 100°. We have little or no snow or ice and frost does not penetrate to any depth. One-fourth of our roads lie in the flat bottom lands of the Red River of the South and three-fourths lie in the hills with occasional grades up to 8 per cent and 10 per cent. Our annual rainfall is about 54 in. and sometimes 16 or 18 in. in a month. We have 47 miles of paved roads and approximately 15 miles of macadam and 120 miles of gravel roads.

Arkansas Line Road, Section I, in Hill Near Mile Post 28

Notwithstanding out 54 in. rainfall, we frequently have long dry spells lasting for many weeks and even months. Such dry spells are sometimes followed by torrential rains,—3 in., 4 in., or even 6 or 8 in. in 24 hours. In the dry spells the clay gravel ravels and gets exceedingly dusty and on steep grades a torrential rain will easily form gulleys in the surface.

The First Oiling Work in 1913.—Add to such difficulties a traffic increasing at the rate of 100 per cent annually and it becomes clear

that an untreated gravel will not sustain the traffic for long, nor be an economical surfacing. We realized this in 1913 and, so far as I know, Caddo Parish was the first locality to try heavy asphaltic oil as a surface treatment for clay gravel roads. In August, 1913, the first oil was applied. All of the mileage to be treated had been completed from six months to a year and was pretty thoroughly consolidated and smoothed out. First the gravel was very thoroughly swept with a rotary steel broom which generally removed from ⅛ to ⅜ in. of fine pebbles, sand and clay and deposited it in windrows on the shoulders of the road. Hand brooms of a type used on city streets were also used to clean any part of surface not thoroughly cleaned by the rotary sweeper. Oil was then applied at the rate of ⅓ to ½ gal. per square yard at a temperature of 225° to 300° F. and was immediately covered with the sweepings previously swept from the surface. Our first oil contained about 85 per cent to 89 per cent bitumen and was obtained from California.

One-half of the road was treated at the time the other being left open for traffic, and though 18 or 20 men followed closely behind the distributors, covering the oil with the sweepings, some vehicles would get on it and pull strips of oil from the surface before we could get it covered with the sweepings. The distributors' nozzles, one or more, would occasionally become clogged and cause skips, all of which had to be touched up a few weeks later, but in 30 to 60 days time travel had ironed out the oil into an almost perfect surface, resembling an asphaltic concrete pavement.

The first oiling was done in August, and in September we had 16 in. of rain, which did not damage the surface in the least. It continued in good surface during the winter of 1913 and spring of 1914. At the end of 12 months, with the exception of a few breaks, it was still in good condition and an auto traveling 50 miles an hour would raise scarcely any dust. In about 15 months the broken places in the surface began to show to a considerable extent and at each break in the oil a chuck hole was forming. To make a long story short, in 18 months the general surface was very rough and not nearly so easy riding as the untreated gravel road.

The freight on the oil made it expensive and the cost of distribution by contract seemed higher than we could afford.

A few years later we were able to procure the same class of asphaltic oil from Baton Rouge, La., at a lower price and with much lower freight rates and we began the oiling of the roads in a systematic way.

Bear in mind when I say oiling that I do not mean the usual coating of light cold oils which are frequently used as dust layers or even those oils slightly heavier which require several coats to form a surface. It has been my belief from the inception of this work that to quickly get the asphaltic surface on the gravel with the least labor, was the true objective.

Kind of Oil Used.—Consequently from the first we have used heavy asphaltic oil such as the grade known in the market as Standard Binder A or Texaco Macadam Binder. Generally we have used Binder A, the analysis of which is as follows:

Standard Binder A

Spec. Gravity @ 77° F.	996/1.010
Flash—Open Cup °F.	390/400
Flash—Elliott °F.	350/365
Spec. Viscosity @ 25° C. (77° F.)	No Flow
Spec. Viscosity @ 100° C. (212° F.)	34/37
Float Test @ 32° C. (90° F.)	360/390
Penetration 100-G. 5 Sec. 77° F.	
Loss @ 163° C. (325° F0) 5 hours	1.0/3.0% 20 G
Penetration of Residue 25° C. (77° F.)	Too Soft
Float test of Residue @ 50° C. (122° F.)	112/118
Penetration 200 G. 1 Min. (32° F.)	
Penetration 50 G. 5 Sec. (115° F.)	
Melting Point (Ring and Ball) °F.	
Asphalt to 100 Penetration	85/90%
Soluble Carbon Bisulphide	99.9%
Soluble 86° Naphtha	84/86%
Ductility	
Fixed Carbon	12/14%

The consistency of this asphalt is such that it takes considerable heat to get it out of the tank cars, which is accomplished by connecting a steam line to the coils provided in such cars and this steam is applied for about 10 or 12 hours, or until the asphalt is hot enough to flow by gravity into our concrete storage tanks or be pumped into our distributors.

Our concrete oil reservoir has steam coils in the lower part into which we can turn live steam when it is desired to withdraw it to distributors.

The Personal Element in Oiling.—One thing I would like to stress at this point is in regard to the personal element entering into the work.

It takes an observant, conscientious and painstaking foreman to get the best results and a complete record of each tank distributed should be kept. In that record should be noted the comparative character of cover (fineness or coarseness), how many days of dry weather preceding the treatment, and every condition of weather, surface or oil which might have an effect on final results. With such a record the failures should gradually be eliminated.

It is quite easy to apply too much oil and without careful checking of surface covered, you will not always know from a foreman's report whether ⅓ or ½ gal. per square yard has actually been used.

Gravel or macadam roads with steep grades treated with heavy asphaltic oils are insured

against longitudinal or transverse gullies which would be caused by heavy rains on untreated surfaces.

Important Details.—In a treatment apparently so simple the details are quite important.

The details necessary for success are: First a surfacing material bound so thoroughly together that when it is swept the gravel or stone remains in place, and only a small part of the binder can be swept out, leaving slight crevices for the oil to get its grip.

A gravel with binder too sandy is almost sure to fail, because you cannot sweep it clean without loosening the surface.

We have found these sweepings make an excellent cover, containing, as it does, particles from ¾ in. down to fine clay. In casting this material on the oil, it is well to cast it in lines parallel with center line and not transversely. The cover must be in quantity sufficient to prevent vehicles from picking up the oil.

After the first application there will be no sweepings, therefore cover will have to be hauled in for subsequent treatments. We sometimes ship in a coarse sand for this purpose and sometimes use a fine pea gravel or broken stone with dust left in. The stone is probably to be preferred, though we find a

Arkansas Line Road, Section K

It is essential to get the surface well consolidated by traffic before applying oil, so that the gravel will not ravel under the oil.

Apply only sufficient oil to completely cover the surface; the first application generally requiring between ⅓ and ½ gal. per square yard.

Later applications generally require about ¼ gal. per square yard.

It would probably give better results if the oil could be left uncovered for from 12 to 24 hours. With us we have few roads over which to detour traffic, consequently we cover the oil immediately after distributing it. A gang of men follows the distributer casting back on the road the fine gravel, the sand and clay previously swept from its surface.

sand graded from fine to coarse serves excellently for the purpose.

I have even seen the oil covered with stiff red clay and, to my surprise, it ironed out in good shape. The clay is not desirable for several reasons, one of which is that it leaves no grit in the surface to reduce slipperiness.

As a matter of fact, we find that our oiled roads are not slippery; the cover composed of the sand and small pebbles or stones gives it a good, almost non-skid surface.

Repairing Breaks.—In repairing the breaks in the oil, we use standard cold patch or Texaco cold patch which costs about 16 cts. per gallon in barrels. This we mix with small stones and allow it to cure for a few days so the volatile oils may escape, and this material

is spread cold and tamped in place after cleaning out loose material from holes and painting holes with cold patch, or some other thin asphaltic oil.

Don't begin using oil on your roads unless you can, and will, afford to apply a renewing coat of say ¼ gal. per square yard at intervals of 12 to 18 months and prepare to begin patrolling oiled roads as soon as oiled. The little breaks must be touched up with oil from hand pouring pots or with cold patch as soon as they appear.

I don't think there is any question of the economy of such a surfacing. We are compelled to use a soft marble for macadam roads —a material which under our traffic of 1,000 to 4,000 vehicles per day would wear into deep holes and ruts in two or three months unless protected by an oil mat.

With the oil surface, this same material does sustain the above mentioned traffic for years at a time, with practically no loss of material and no rutting. We have such macadam surface constructed over 5 years ago within 3½ miles of the Court House at Shreveport (a city of 75,000) and carrying heavy oil field traffic, and they have been maintained in good surface for less than $500.00 per mile annually and with no additional rock.

Several coats of oil have been applied and sufficient oil has now been applied to cause some waviness in surface.

A little later we will have to scarify the surface lightly, re-roll it and re-oil it.

The same statements apply to many miles of our clay gravel roads which are in excellent condition several years after first application of oil.

The Louisiana Highway Commission has been keeping a careful check of traffic on the state highways, and, in a recent issue of their monthly magazine, it is stated that the maintenance costs on untreated gravel roads amount to about $600 per mile annually and that notwithstanding this expense for maintenance, traffic is wearing away or winds and rains carrying away about 1 in. of gravel per year, estimated to cost $1,000 per mile per year, or a total cost of approximately $1,600 per mile per annum. With the oil surfacing, the $500 or less, per mile maintenance charge is the total annual cost, because the gravel cannot wear away, blow away or wash away.

Savings from Oiling.—Then consider for a moment the saving which oiling effects for the users of the road. Information from university tests and actual costs in several parts of this country indicate that the saving to automobile owners in gas, oil and tires effected by a paved surface in comparison with an ordinary gravel surface is at least 1½ ct. per mile and even 2 ct. per mile. I am convinced that, as compared with a loose gravel surface such as we have in Louisiana during our long dry spells, the saving effected by oil surfacing must be at least 2 ct. per mile.

As a matter of fact, one of our transfer companies runs about 50 busses a day over different routes out of the City of Shreveport. Some of these busses are confined to roads almost exclusively surfaced with oil, while others are kept on gravel roads unsurfaced, and although these unsurfaced gravel roads are machined almost daily, they have much loose gravel. In looking over the statement of maintenance costs on the equipment of this company which had been worked out in the cost per mile, I was interested in the fact developed by those costs, that the busses operating over the untreated gravel roads were costing about 2 ct. more than those operating over the paved and the oil surfaced roads. And the difference in cost to the Transfer Company on seven busses operated over the untreated road amounted to $6,000 more than for the same mileage in a year over the oil surfaced roads.

This, mind you, is but the loss of one company on seven busses. What must be the loss to the whole traffic?

Of course you must add to these savings by the use of oil, the very great saving to the people in the abatement of the dust nuisance; the increased pleasure in the use of the road; the decided factor of safety in the prevention of collisions caused by dust and the enhanced value of property along the road because of the abatement of the dust.

Cost of Oil Surfacing.—I think I have made out a case for oil surfacing; what then is the cost?

We keep careful cost accounts on all our work, and for 5 or 6 years we find that there is but little variance in the cost. It runs from 5 to 8 ct. per square yard for first treatment, or $500 to $800 per mile on an 18 ft. surface. These costs include $30 per day for use of oiler, also the cost of sweepers, labor, foremen, trucks and covering material. The cost varies depending on length of haul, length of the stretch to be oiled and some other variable factors.

We sometimes take the oil over 40 miles from town and apply it at not to exceed 8 ct. per square yard.

If we could continue this work over any regular period, using the equipment each day, we could reduce these costs considerably, but we only oil, or re-oil, a mile, or perhaps 2 or 3 miles in one job, and then move perhaps to a point 50 or 60 miles away, where the next oiling is necessary. A typical cost sheet is as follows:

Ida-Missionary Road Oiled—Outfit No. 2, July, 1925
Station 00 to Station 244.....4.62 Miles
Roadway 12 ft. Wide.....Total 32,533 Sq. Yds.

Recapitulation Cost

Trucks and Drivers	$ 75.15
Oilers and Drivers	366.68
Sweeper and Drivers	201.10
Labor Cleaning Road and Cov.	328.49
Oil (13,700 Gal.)	1,438.50
Foreman	60.69
Total	$2,476.61
Total Sq. Yd. Oiled	32,533
Total Miles	4.62
Total Gal. Oil	13,700
Gal. Per Sq. Yd.	0.421
Cost Per Sq. Yd.	.0761
Cost Per Mile	$ 535.88

Note: Hauled from Shreveport—40 miles.

I shall append some figures giving typical detail costs of this character of work.

Cost Data.—Section "I" Arkansas Line Road—24.2 mile post to 285 mile post 16 ft. wide. Oiled in 1922, at cost of $583 per mile or 6 4/10 ct. per square yard. Second application of oil Nov. 7 to 15, 1923, at cost of 4 ct. per square yard, using coarse and fine sand for cover. Maintenance on this section for the 9 months of 1925—$248 per mile.

Section "K" of Arkansas Line Road—8.4 miles; June 27, 1922. 14 ft. in width. Cost

Mooringsport Road about 4¾ Miles from Courthouse at Shreveport, La.

We have recently tried the experiment of curbing a macadam road and oiling it to see how long we can maintain it in good surface. We were led to try this because almost invariably the oil surface begins to get ragged at the edges and more repairs are called for there than on the balance of the surface. This has only been completed about one year so it is too early to say much about it except that it looks like it is there for a good while to come, and certainly after a few years it should make an excellent base for some higher asphaltic type of pavement.

per mile $382; or per square yard 4 7/10 ct., using 0.334 gal. per square yard. This section maintained for 9 months of 1925 for $200 per mile.

Mooringsport Road, Section "N"—This was an old gravel road with gravel 4 in. to 6 in. in depth. In March, 1922, from 3 in. to 4 in. of stone was added and 0.38 gal. of oil per square yard applied and in July, 1922, a light coat was applied. The total cost of the first application was $714 which figures out at $593.20 per mile or 6 cts. per sq. yd. The detail costs were as follows:

5/6	1 Truck and Sweeper 1 day	$ 35.00
5/7	1 Truck and Sweeper 1 day	35.00
	2 Oilers and Helpers 1 day ea. (@ $30)	60.00
	1 Truck for men @ $8	8.00
	Labor 50 hrs. @ 22½ ct.	11.25
	Labor 100 hrs. @ 20 ct.	20.00
	Foreman 10 hrs. @ $8	8.00
5/8	2 Oilers 1 day each	60.00
	Truck for men	8.00
	Labor 50 hrs. @ 22½ ct.	11.25
	Labor 100 hrs. @ 20 ct.	20.00
	Foreman	8.00
	Plant Expense 2 days @ $15	30.00
	Hauling sweeping from roadside, Outfit No. 45, 2 days	75.00
	4400 Gal. Std. Binder "A" @ 8 ct.	$52.00
	1¼ Miles	$741.00

1 mile $593.20; 1 sq. yd. 6 ct.; Gals. per sq. yd., .38.
Maintenance—9 mo. of 1925, $210.94.

Mooringsport Road—3,700 ft.—18 ft. wide. Station 288 plus 80 to 325 plus 80. First application Standard binder "A". 30 Yds. No. 3 Winndield Stone and 30 Yds. bank sand covering.

5/22	30 Yd. No. 3 rock $4.25 per yd. in place	$127.50
5/24	30 Yd. Bank Sand $1.25 yd. in place	37.50
5/25	1 Oiler 1 day	30.00
	1 Truck Sweeping, and hauling men	15.00
	Labor hand-sweeping and covering	31.75
	Foreman	8.00
	Plant Expense	15.00
	2500 Gal. Std. Bind. "A" @ 8 ct.	200.00
	1 Sweeper 1 day	7.50
	For 0.7 Miles	$472.25
	For 1 Mile	$674.64
	1 Sq. Yd.	.064
	Gal. per Sq. Yd.	.34
Cost of Maintenance 1925 to date, 9 mo.		144.90

(Oiling)

Lucas-Forbing Road—Oiling, May 1926.
12-foot Roadway Oiled.
1st Application Standard Binder "A."

Recapitulation Cost

Trucks and Drivers	$ 221.00
Oiler and Driver	84.75
Sweeper and Driver	79.75
Plant Expense	6.25
Sand (129 Cu. Yds.)	236.07
Labor-Loading Sand	53.87
Labor-Covering Oil	166.68
Binder "A" (7000 Gal.)	610.33
Foreman	53.83
Total	$1,512.53

Station 00 to 136.....13600 Lin. Ft. x 12 ft.
18133 Square Yards.....2.576 Miles.
Total Gallons Standard Binder "A".....7000.
Gallons per square yard.....$0.386.
Cost per square yard.....$0.0834.
Cost per mile.....$587.13.

Road Building in Salvador

The National Assembly of Salvador passed a law, effective Nov. 15, 1915, creating a Highway Board for each department of the country. The boards, working with the Ministry of Fomento, have charge of road improvement and collect the necessary funds. Each person residing in the Republic must contribute a certain sum or work a certain number of days on roads and allied works, according to their capacity to pay. An American firm was awarded a contract for street paving and sanitary works in the city of San Salvador. The total cost will be $2,993,170, of which it is estimated that $1,239,750 will be spent for street paving. In October the same company was given the contract to build 800 miles of roads at an expenditure of about $12,000,000. Salvador is stated to already have the best road system in Central America.

Highway Traffic Analysis

Summary of Committee Report Presented at 5th Annual Meeting of Highway Research Board

By G. E. HAMLIN, *Chairman*,
Of Connecticut State Highway Commission

The Three-Lane Two-Way Roadway.—A 3-lane 2-way roadway is one upon which the traffic movements are in both directions, and which is only wide enough for three moving vehicles to be abreast.

The actual traffic capacity of a 2-lane roadway varies within wide limits. It is evident that a 3-lane roadway will permit vehicles to pass each other with a greater frequency than on a 2-lane road. The 3-lane roadway, however, provides conditions under which accidents may frequently occur. The committee recommends the use of a 4-lane roadway when the capacity of the 2-lane 2-way roadway is exceeded.

Highway Traffic.—Transportation surveys indicate a close relationship between population per square mile, the trend of population, growth and industrial development, and the amount of traffic using the highways.

The prediction of expected future traffic based on the projection of the trend of motor vehicle registration is a reasonably accurate measure of future highway traffic.

Elimination of Obstacles Impeding the Free Flow of Traffic.—The movement of traffic over any route depends upon its ability to move freely at all points.

The committee believes that the elimination of obstacles to traffic on many highway routes will be justified by the increase in the safe movement of traffic; and in some cases, the program of widening can be economically deferred by this method.

The committee recommends, in the construction program for highway improvement, that there shall be seriously considered the planning for arterial highways outside the congested areas.

The committee is of the opinion that, in many cases, the installation of a fixed signal supported by a pedestal at the intersection of highways is not justified.

Adequate Rights-of-Way.—The committee recommends the following:

1. Determination of present right-of-way.
2. A highway transport survey to determine necessary required widths.
3. Acquisition of additional necessary width.
4. Simplification of method of acquisition to permit immediate occupancy.

Highway Finance: Federal, State and Local

Conclusions and Supporting Data Indicating Need for Revision of Present Practices in Highway Finances Given in Paper Presented Jan. 12 at Convention of American Road Builders Association

By THOMAS H. MacDONALD
Chief U. S. Bureau of Public Roads

Highway finance in all its phases would not be exhausted as a topic for exposition if all the sessions of this Association were limited to this one subject.

There is great progress in the professional field of highway engineering. There is fully comparable progress in the field of power and mechanical equipment and its utilization for construction and maintenance of highways. The growth in the production of materials is apparently keeping pace.

The developments in the field of highway transportation continually reach beyond our expectations. First, we were astonished by the increase annually in the number of automobiles brought into use. Next, the motor truck appeared in numbers beyond our belief. Now we are just awakening to the spectacular and widespread ramifications of motor bus services. Already in the common carrier field the motor truck is insignificant as compared with the motor bus.

Highway Administration—The Laggard.—In this great nation-wide panorama of highways and highway transport, the laggard in the procession of progress is highway administration and the very core of highway administration is this matter of highway finance.

Highway administration as here used is not to be confused with the administration of state highway departments or their handling of public roads. Much progress is being made in methods and economy of production by a majority of these departments. For these same results generous credit should also be given to the material and equipment industries and to the road contractors and their organizations.

Highway administration in the national sense, is the business of organizing into system, under responsible authority, 3,000,000 miles of public roads and improving, maintaining and policing them for the safe and economical operation of 20,000,000 motor vehicles —and one thing more, financing these operations on a profit earning basis. This is a statement of the partial problem. The whole includes many thousand miles of urban streets. A big business enterprise conducted by the public for itself and the foundation for the whole structure is the financing.

Important Aspects of Highway Finance.—The highway expenditures for a nation must be considered in their relation to all the factors constituting a nation's economy. For several years the United States has been operating on an annual program of approximately one billion dollars for rural highways. This is a large program. It is large for a nation liberally endowed with natural resources and with vast accumulated wealth. The dimensions are so large, their continuation undiminished is the best evidence of general public support. But this alone is not sufficient to give confidence. There are and should be questions: Can it a program of such proportions stand the test of cold analysis? Can it justify itself in a critical determination of its relative importance in the whole list of desirable public activities? Are its dimensions in harmony with the service needs of the traffic? These questions are timely and sane. They should be answered. But they only concern themselves with the total money outgo. There are other questions equally as important. For example: Are the taxes falling too heavily on some classes of property and on certain governmental entities? This and many similar questions relate to the other side, that is, the incomes or receipts to support the program. Perhaps, most important of all are these questions: What progress is being made and what will be the trend of the total annual highway bill in the future? Will it be up or down?

These aspects of the subject of highway finance appear to be the most important since there is constant need for legislative and executive determination of highway policies—financial, engineering and administrative, and unless more progress is made soon than resulted during the past year, the business cannot succeed.

Engineering Policies and Financial Program.—The financial program cannot stand alone, and while it may be said that in these, the

earlier years of the great development of motor transport, the financial policy determines the engineering policies and program of road construction and maintenance, in the course of a period of years the present engineering policies will determine what the financial program must be. The two are intimately interwoven, and of the two the economic engineering aspect will in the end govern. It will govern because there are certain laws which can never be defeated over a period of time. These are economic laws, and the most important one bearing upon highway finance is the law of compensation for waste. All waste must be paid for in one form or another. This is inevitable and the waste in highway transport resulting from the lack of adequate highways will cost the nation more than to provide them. This truth I have stated over and over in many forms, and the results of transport surveys and economic studies as they become available in larger measure are supporting the certainty of the workings of this principle. It is no longer necessary to hazard guesses. While it is not yet possible to present all the facts which have a bearing on the subject of a nation's highway finance, in an entirely correct form, the facts and statistics available are fairly accurate with reference to Federal and state finances, and can be estimated with reasonable exactness for the local expenditures and results.

What a Study of Available Data Shows.—The study of a mass of available data leads to certain conclusions that appear so important and so indicative of needs for thorough going revisions, modifications and adjustments of our present practices in highway finance and expenditure, that this paper is presented in two parts—first, the conclusions with only incidental reference to the data upon which the conclusions are based, and second, the supporting date.

These conclusions are presented in this form for the frank purpose of placing before the public and particularly before the highway executives and legislative bodies facts which indicate the necessity for drastic changes in legislative and administrative highway policies. Also, careful consideration of the data here presented together with other available information leads directly to the conclusion that unless major changes are made in administrative and engineering highway policies we cannot hope for a reduction of expenditure or a decrease of the taxes necessary to provide the annual costs of highways unless this be at the sacrifice of the capital investment through deterioration or loss to the public through avoidable waste in highway transportation. These conclusions cover a wide range, but aim to touch phases of the subject of highway finance which are presently of outstanding importance.

Conclusions.—The major responsibilities of the public business of the nation fall most heavily upon the local rural and urban governments, next upon the Federal Government and least upon the State governments. The ratio fixed by 1923 expenditures is about 5.1 local, rural and urban; 3.5 Federal, 1.5 State.

Federal expenditures over several years for highways are about 2.5 per cent of total Federal Budget. For 1925, the peak, about 3 per cent of 1925 total Federal expenditure.

The failure of one governmental agency to do a full share of any activity common to all does not lessen the total expense for this activity, but only shifts the burden between budgets.

There is a direct relation between bonds and progress in the construction of durable roads evidenced by the fact that only those States which have issued bonds have made any considerable progress in the mileage of durable pavements built. At the end of 1924, of the 467,000 miles of surfaced highways reported, 65.8 per cent were low type, 24 per cent were medium, and only 10.2 per cent consisted of the more durable forms of pavement.

The pay-as-you-go policy adopted by a considerable number of states is having two principal effects. First, to limit the expenditure of funds to types of road that admittedly are not adequate for present traffic. Second, to force upon the counties bond issues. In 24 states which have no state bond issues there have been issued since 1921 upwards of one-half billion dollars in county road bonds, and these same states had issued prior to 1921 about the same amount in road bonds, again supporting the conclusion above that the failure of one governmental unit to carry a full share of the cost of this public undertaking is only shifting the burden to other units of government and increasing rather than decreasing taxes.

Of the funds available for expenditure under the supervision of the state highway departments in 1924, 15.9 per cent was transferred from counties, 16.5 per cent came from Federal aid, 40 per cent from motor vehicle fees and gas tax. That is, 72.4 per cent of the total State highway program estimated at $555,000,000 was financed other than by using the credit of the States or the general taxing power of the states.

That the financing of the state highway program through contributions from the counties is wrong in principle and will cost the public more in the end.

Interstate traffic is indicated for a number of representative states at upwards of 18 per cent of the total on the state highway system. The

funds available from Federal aid for the 1924 state highway program amounted to 16.5 per cent of the total. Considering only the funds available for the state highway program it appears there is a reasonable contribution from the Federal Government. Considering the whole program, state and local, the contribution from Federal funds amounts to an average of not over 7.5 per cent or 8 per cent.

Principles of highway finance adopted by the American Association of State Highway Officials are supported by the evidence now available.

A greater percentage of state highway funds should be expended for more durable construction, and the state highway departments should be financed without recourse to county contributions.

The states must extend the supervision of their state highway departments over a larger mileage of local roads to insure their maintenance, thus preserving the investment. Unless this is done we are headed toward larger local expenditures for highway purposes or a depreciation of roads already built.

Responsibilities of Various Governmental Agencies.—The various major activities which the public has undertaken to perform for itself through the Federal, State and local governments, each requiring the expenditure of public funds, are shown in the following schedule. The extent of taxing power exercised by these governmental units and the allocation of the funds produced through taxation to the various activities are determined by the constitutions of State and Nation and the laws of the legislative bodies or by direct popular vote. The funds, therefore, allocated to any one activity as a whole may be fixed by the action of one governmental agency or may be the total of the sums determined by action of several or all of the governmental units.

2. **The Federal Highway System.**—The original system of roads on which all Federal funds are used was fixed by law at a maximum of 7 per cent. This system now includes 179,000 miles. There have been improved or improvement provided for up to July 1, 1925, 57,560 miles with Federal and state funds. Improvement with state funds only of more than 65,000 miles brings the total to more than 122,500 miles. Since this system is coincident but not coextensive with the state systems, this discussion will consider the combined Federal Highway System and state systems under one class.

3. **Highway Improvement Status.**—On the basis of one billion dollars' annual expenditure, the average annual cost of our public roads is approximately $300 per mile.

The total rural highway mileage of the United States at the end of 1924 amounted to 3,002,916 miles. The responsibility for the improvement and maintenance of these highways is divided between the highway departments of the several states on the one hand and the

Group One

Major governmental functions primarily exercised without financial interdependence of governmental units

Federal	State	Local Rural	Local Urban
War debts and obligations	Soldiers Bonus	Local Government	Local Government
Federal Government	State Government	Public Schools	Public Schools
Army and Navy	Higher Education	Eleemosynary	Sanitary Provisions
Postal Service	Eleemosynary	County Courts	Water Supply
Indian Affairs	State Courts		Fire Protection
Prohibition Enforcement			Police
Business Service			Street Cleaning
Special Services to Education and Labor			Waste Collection and Disposal
			Charity

Group Two

Major governmental functions involving financial interdependence

Federal	State	Local Rural	Local Urban
Federal aid to agriculture	State aid to school and agriculture	County aid to agriculture	

Group Three

Major Governmental Functions Providing Recreational Facilities

Federal	State	Local Rural	Local Urban
National Parks	State Parks	County Parks	Parks
			Recreational facilities

Group Four

Major Governmental Functions and Sources of Income for Regulating or Providing Transportation Facilities

Federal	State	Local Rural	Local Urban
Interstate Commerce Commission	State Highway Department	County Highway Department	City Highway Departments
Bureau of Public Roads	Motor Vehicle, Railroad or Public Utilities Commissions	Highway Police	Traffic Police
Waterway	General Appropriations for roads	General appropriations for roads	General appropriations for roads and streets
Appropriations for road aid	Special taxes for roads, license, gas	Road bonds	Road and street bonds
Appropriations for forest roads	Road bonds	Convict labor for roads	Special assessments for streets
River and Harbor appropriations	Convict labor	Special assessments for roads	Appropriations for harbor, port
	Canals, river and harbor or port appropriations		

counties and townships on the other. These two types of control may be called state control and local control. Of this total highway mileage 259,721 miles, or 8.6 per cent, were under the supervision and control of state highway departments; the local control extended over 2,743,195 miles, or 91.4 per cent of the country's total highway mileage. The significant fact is that such a small part of the total highway mileage is found to be under direct or indirect control of state highway departments. The counties and townships and local road districts are still responsible for the construction and maintenance of by far the larger portion of all the highways. The relationship of the importance of the highways under these two types of control so far as traffic conditions are concerned is a wholly different matter.

No definite or uniform policy has been followed by the states in determining the amount of mileage that should be placed within the control of the respective state highway departments and the amount of highway mileage which should be left to the counties and townships to maintain as had been the policy prior to the establishment of any centralized supervision or control on the part of a state. As has been indicated above, the state highway system mileage averages 8.7 per cent of the total mileage. In 29 of the states the mileage under state control comprises less than 10 per cent of the total highway mileage of these respective states; in 17 states it ranges between 10 and 20 per cent; in Vermont it is 30 per cent, and in Rhode Island 32.8 per cent. Oklahoma has the smallest proportions of its highway mileage under state control; the percentage there is 4.9 per cent. The tendency, therefore, seems to be to keep the mileage of the state highway systems down to the main traveled highways and important traffic routes.

Total Surfaced Highway in United States.—The total surfaced highway mileage of the country at the end of 1924 was 467,865 miles, which was 15.6 per cent of the country's total rural road mileage. This includes the surfaced mileage of the state highway systems and also that part of the surfaced highway mileage which is under control. The ratio of surfaced mileage to the total highway mileage differs widely in the various states. While the average is 15.6 per cent, the actual ratios range from 10.1 per cent in Kansas to 49.3 per cent in Indiana. Indiana is the only state of which it may be said that approximately as much as half of its highway mileage is improved with some type or other of surfacing. The extent to which this surfacing of highway mileage has been carried on can best be shown in the following tabulation, which presents a grouping of the several states in accordance with ratios of surfaced mileage to total mileage:

Ratio of Surfaced Mileage to Total Mileage

0-9 Per Cent	10-19 Per Cent	20-29 Per cent	30-39 Per Cent	40-49 Per Cent
Arkansas	Arizona	Alabama	Florida	Indiana
Iowa	Colorado	California	Idaho	New Jersey
Kansas	Connecticut	Kentucky	Massachusetts	
Missouri	Delaware	Maryland	New York	
Montana	Georgia	Michigan	Ohio	
Nevada	Illinois	Minnesota	Vermont	
New Hampshire	Louisiana	North Carolina	Washington	
New Mexico	Maine	Oregon	Wisconsin	
North Dakota	Mississippi	Rhode Island		
Oklahoma	Nebraska			
South Dakota	Pennsylvania			
West Virginia	South Carolina			
Wyoming	Tennessee			
	Texas			
	Utah			

In 13 of the states the surfaced mileage ratio is less than 10 per cent of the total mileage; in 15 states it is between 10 and 19 per cent; in 9 states it is between 20 and 29 per cent; in 8 states it is between 30 and 39 per cent, and in 2 states the surfaced mileage ranges between 40 and 49 per cent. These percentages indicate on the face of it the extent to which highway improvements of various kinds have been attempted by the several states. It is not an accurate indication, however, of the quality and character of such improvements. That will be shown later when an analysis of the various types of surfacing will be made.

The total surfaced highway mileage of the country is 467,905 miles. That part of this surfaced mileage which is included within the state systems is 128,347 miles, or 27.4 per cent; 339,558 miles, or 72.6 per cent, are included within that part of the highway mileage which is under the control of counties and townships. While the state highway systems comprise only 8.7 per cent of the country's mileage, they do include 27.4 per cent of all of the surfaced mileage.

The state highway systems consist of 259,721 miles. Of this total amount, 128,347 miles, or 49.5 per cent, are surfaced and 131,374 miles, or 50.5 per cent, are unsurfaced. Of

the state highway systems it can be said that about half the mileage is surfaced.

The total mileage under local control is 2,723,195 miles. Of this amount 339,558 miles, or only 12.4 per cent, are surfaced and 2,383,637 miles, or 87.6 per cent, are unsurfaced. While there are more miles of surfaced highways in the local systems than in the state systems, the ratio of surfaced mileage to the total mileage in the state systems is greater in the state systems than the corresponding ratio in the local systems.

Kinds of Surfacing.—The 467,905 miles of surfaced highways in the United States are improved with various kinds of surfacing. The amount of each type of surfacing and the percentage which that mileage bears to the total surfaced mileage is set forth in the following tabulation:

Surfaced Highways, End of 1924

Type of Surfacing	Miles	Per Cent
Sand-clay	63,681	13.6
Gravel, untreated	244,282	52.2
Waterbound macadam	60,234	12.9
Surface treated macadam and gravel	26,680	5.7
Bituminous macadam	17,539	3.7
Sheet asphalt	2,260	.5
Bituminous concrete	7,443	1.6
Cement concrete	31,146	6.7
Brick	4,319	.9
Miscellaneous	10,318	2.2
Total	467,905	100.0

These types of surfacings may be grouped as follows:

Type of Surfacing	Miles	Per Cent
Low	307,964	65.8
Medium	112,250	24.0
High	47,691	10.2
	467,905	100.0

In the low type group are included the sand-clay and the untreated gravel types; in the medium group are included the water-bound macadam, the surface treated macadam and gravel, and the bituminous macadam. There are also added to this group 7,796 miles of miscellaneous roads which are found in the state of Pennsylvania and which that state failed to classify. It is believed, though, that most of the roads referred to may be regarded as of medium type. The high type group includes pavements of all kinds, such as sheet asphalt, bituminous concrete, cement concrete, brick, and 2,521 miles of miscellaneous roads which consist for the most part of wood, asphalt, or stone block surfacing.

These percentages relate only to the total surfaced mileage. Of this surfaced mileage it may be said that roughly two-thirds of all the surfaced mileage is of a low type of surfacing, one-quarter is of a medium type, and about 10 per cent is of the high type.

Progress in Surfacing Highways.—The progress which has been made with respect to the surfacing of the highways of the country can best be shown in the following tabulation:

Highway Improvements in the United States, End of 1924

	Miles	Per Cent
Unsurfaced highways	2,535,010	84.4
Low type surfacing	307,964	10.3
Medium type surfacing	112,250	3.7
High type surfacing	47,691	1.6
Total	3,002,915	100.0

These figures of highway mileages of surfaced and unsurfaced highways and the corresponding percentages tend to mislead the reader and make him conclude that the improvements and surfacings made thus far serve the public in a very inadequate manner. In this connection it must be borne in mind that the highway traffic of this country is not distributed uniformly over the country's total highway mileage. If that were the case, then we could say that only 15 per cent of the traffic was afforded surfaced highways. The facts in the situation are, as everyone familiar with the highway situation knows full well,

During this period the total highway mileage increased from 2,151,379 miles to 3,002,916 miles, or 13.9 per cent. The surfaced mileage, during the same period, increased from 153,530 miles to 467,905 miles, or a three-fold increase. In 1904 the total surfaced mileage constituted 7.14 per cent of the country's mileage; by the end of 1924 this percentage relationship had risen to 15.6 per cent. These increases in the number of miles of surfaced highways and the percentage increases do not by any means indicate the exact extent or degree of highway improvements. The actual types of surfacing are better evidences of the nature of the improvements. Prior to 1914 the data available do not show the various kinds of surfacings. In the following tabulation a comparison is made for the years 1914, 1921 and 1924:

Comparison of Types of Surfaced Roads 1914, 1921 and 1924

	1914		1921		1924	
Type of Surfacing	Miles	Per Cent	Miles	Per Cent	Miles	Per Cent
Sand-clay	44,154.7	17.2	63,339	16.3	63,681	13.6
Gravel	116,058.1	45.1	199,899	50.5	244,282	52.2
Waterbound macadam	64,898.4	25.2	58,036	14.7	60,234	12.9
Surface treated macadam and gravel	.....	.....	19,309	4.9	26,680	5.7
Bituminous macadam	10,499.8	4.1	10,264	2.6	17,539	3.7
Sheet asphalt	.....	.....	1,601	.4	2,260	.5
Bituminous concrete	.....	.....	4,978	1.2	7,443	1.6
Cement concrete	2,348.4	.9	15,611	3.9	31,146	6.7
Brick	1,593.4	.6	3,333	.8	4,319	.9
Miscellaneous	17,738.2	6.9	11,390	2.9	10,318	2.2
Total	257,291.0	100.0	387,760	100.0	467,905	100.0

Federal Income and Expenditures.—The report of the Secretary of the Treasury for the fiscal year 1925 shows:

RECEIPTS—SOURCES

Income and profit	47 per cent
Miscellaneous internal revenue	22 per cent
Customs	14 per cent
Foreign obligations	5 per cent
All other	12 per cent
Total collections	$3,780,148,000
Total expenditures	3,529,643,000
Surplus	$ 250,505,000

EXPENDITURES

1. Public debt retirements chargeable against ordinary receipts	$ 466,000,000
2. Special expenditures, which include interest on the public debt, tax refunds, postal deficiencies, Panama Canal, operations of Shipping Board, War Finance Corporation, and other special accounts, purchase of obligations of foreign governments, investment of trust funds, and other items of similar nature	1,226,000,000
3. General expenditures, which include the legislative establishment, executive proper, the 10 departments, the Veterans' Bureau, other independent offices and commissions, and the District of Columbia	1,837,000,000
Total	$3,529,000,000

General expenditures equal 51 plus per cent.
Character of general expenditures:

1. War and Navy	$708,000,000
2. Veterans' Bureau	385,000,000
3. Pensions	218,000,000
4. All other Federal departments and independent establishments	526,000,000

This fourth division is approximately 29.5 per cent of general expenditures; or 29.5 per cent of 51 per cent of total equals, say, 15 per cent of total ordinary, just slightly in excess of one-seventh of total Federal Government expenditures for 1925.

For What Purposes, 1925, Warrant Basis

Indian affairs	$ 39,000,000
Highways	105,000,000
District of Columbia	33,000,000
Treasury	128,000,000
All others	221,000,000

Included in this last—all others—are: Legislative establishment, the executive proper, the Civil Service Commission, the Employees Compensation Commission, the Federal Board for Vocational Education, the Federal Reserve Board, the General Accounting Office, the Interstate Commerce Commission, the Federal Trade Commission, the Tariff Commission, and all activities of the Department of Agriculture (exclusive of good roads), Commerce, Interior (exclusive of pensions and Indian affairs), Justice, Labor and State.

Secretary Mellon in his report (page 21) says: "We still make, as a result of the war, tremendous expenditures for debt retirements, interest on the debt, care of disabled veterans, etc., but these are unavoidable and will be necessary for many years to come. It is the inevitable price which we continue to pay for the war. In this connection it is of interest to point out the proportion of Government expenditures which are due to war. While it is not possible to segregate entirely all expenditures which might fall in this category, if we add to the disbursements for public debt retirements interest on the debt, War, Navy, Veterans' Bureau, and pensions, other extraordinary expenditures, such as adjusted compensation and the increased outlays by the Treasury, the expenditures which are directly or indirectly attributable to war and the national defense compose over 80 per cent of total Federal expenditures. The amounts spent by this Government in aid of agriculture and business, for science, education, better roads, and other constructive efforts are insignificant when compared with outlays due to war and national defense.

Of the total Federal expenditures, $3,530,000,000, the combined Federal aid and forest highway payments were $105,000,000, or approximately 3 per cent of the total. This is the peak and represents neither past nor future average. Probably at present rate the average over several years will be about 2.5 per cent or less.

By doing away with the entire Federal road program the taxpayer without dependents on, say, $5,000, income tax $37.50, would save about 88 cents.

Governmental Expenditures, 1923

Federal	$ 3,648,000,000	(actual)	$33.20 per capita
State	1,310,000,000	(actual)	11.82 per capita
Local	5,142,000,000	(estimated)	46.41 per capita
Total	$10,100,000,000		$91.40

Estimated Total Highway and Street Expenditure Compared with Total Expenditures All Purposes

	Expenditures for Highways	Total Exp. All Purposes	Ratio of Highway Exp. to Total Exp. Per Cent
Federal Government	$ 90,000,000	$ 3,648,000,000	2.5
State and local Governments	1,210,000,000	6,452,000,000	18.7
Total	$1,300,000,000	$10,100,000,000	Avg. 12.9

Total Income and Funds Available for Highway Purposes by and Under Supervision of State Highway Departments, 1924

	Amount	Per Cent
State highway bonds and notes	$101,653,327	18.3
State tax levied for highways (T)	18,282,878	3.3
Appropriation by state for highways (T)	20,084,324	3.6
Miscellaneous state income for highways (T)	13,349,610	2.4
Motor vehicle fees for use on roads	174,816,973	31.4
Gasoline tax applicable to highways	47,810,615	8.6
Transferred funds from counties, etc. (T)	87,998,486	15.9
Federal aid	91,400,832	16.5
	$555,397,045	100.0
The sources of the above funds are:		
Funds from loans	$101,653,327	18.3
Funds from taxes (T)	139,715,298	25.2
Funds from motor vehicles	222,627,588	40.0
	$555,397,045	100.0

Roads Built and Surfaced in 1924 by or Under Supervision of State Highway Departments

	Miles
Earth roads established to grade and drained	5,956.6
Surfacing Work	**Miles**
Sand clay	1,384.8
Untreated gravel	7,659.8
Waterbound macadam	467.1
Surface treated macadam and gravel	999.5
Bituminous macadam	996.9
Sheet asphalt	119.9
Bituminous concrete	564.4
Cement concrete	4,850.6
Brick	161.6
Miscellaneous	2.8
Total surfaced mileage	17,207.4
Total mileage	23,164.0

Roads Built and Surfaced by Counties and Towns in 1924

	Miles
Unimproved and earth partially graded	6,407.7
Earth to established grade and drained	7,732.6
Surfacing Work	**Miles**
Sand-clay	1,615.2
Untreated gravel	8,805.1
Waterbound macadam	966.1
Surface treated macadam and gravel	467.7
Bituminous macadam	903.3
Sheet asphalt	95.9
Bituminous concrete	167.0
Cement concrete	1,229.3
Brick	25.9
Miscellaneous	58.2
Total surfaced mileage	14,333.7
Total mileage	28,474.0

The above figures do not include the following states, for which data could not be obtained:

Delaware	Kansas	Nebraska
North Carolina	Ohio	Oklahoma
Oregon	Pennsylvania	Utah
Vermont	Virginia	Washington
West Virginia		

Calendar Year Basis

	Number of Motor Vehicle Registrations		Population of United States	Persons Per Vehicle
1909	312,000		90,691,000	291.0
1914	1,711,000		97,927,500	57.0
1919	7,565,000		105,003,000	13.9
1924	17,592,000		112,079,000	6.4
1925	20,100,000	(Est.)	113,494,000	5.6

Cal. Year Basis	Excise Tax (Began 1918)	Motor Vehicle Receipts (Began 1903)	Gas Tax Receipts (Began 1919)	Total
1909		$ 943,000		943,000
1914		12,382,000		12,382,000
1919	$ 48,834,000	64,697,000	751,000	114,282,000
1924	139,202,000	225,492,000	79,987,000	444,681,000
1925	130,000,000	256,000,000	165,000,000	551,000,000
Personal Property—1925				$100,000,000
Municipal and Local Licenses—1925				10,000,000
Total—1925				551,000,000
Estimated total				$661,000,000

Interstate Traffic.—The traffic crossing state boundary lines is for the most part a local movement. In Pennsylvania at stations within 16 miles of the state line it was noted that almost half of the passenger cars were foreign cars and about a third of the motor trucks.

The foreign passenger car and motor truck movement noted at interior points in Pennsylvania shows that 12.4 per cent of the passenger cars were foreign cars and 1.8 per cent of the motor trucks. These interior points taken as samples were distant from the state line from 42 to 110 miles. The average distance of these stations from the state line was 68 miles.

A similar study in Ohio shows that at interior points distant on the average 68 miles from the state line the foreign passenger car averaged 16.8 per cent of the total passenger cars and the motor trucks 4.5 per cent. These stations ranged from 41 miles to 120 miles from the state line.

Taking all the stations in Ohio into account we find that the foreign passenger cars amount to 18.6 per cent and the foreign motor trucks 7.4 per cent.

In Pennsylvania the foreign passenger cars were 17.7 per cent and the foreign motor trucks 8.2 per cent.

In Connecticut 21.1 per cent of passenger cars were of foreign registration and 10.9 per cent of the motor trucks were of foreign registration. These foreign vehicles make a proportionately larger use of the highways than the local vehicles. The passenger car mileage of the foreign cars was 43.4 per cent of the total passenger car mileage,—the foreign motor truck ton-mileage was 32.8 per cent of the total motor truck mileage.

On the primary roads of Maine the foreign passenger cars were 23.3 per cent of the total number of passenger cars and the foreign motor trucks only 2.1 per cent.

County Bonds (Road and Bridge) Sold During Years 1921-22-23-24 In States Having No State Bonds

State	Total sold in 4 years 1921-24, Incl.
Arizona	$ 4,907,000
Arkansas	26,808,265
Connecticut	1,157,500
Florida	31,312,143
Georgia	6,348,924
Indiana	55,415,420
Iowa	16,195,831
Kansas	14,686,057
Kentucky	7,905,978
Louisiana	28,088,237
Minnesota	36,904,477
Mississippi	10,020,212
Montana	2,501,800
Nebraska	3,890,769
*North Dakota	
Ohio	40,511,219
Oklahoma	16,681,300
South Carolina	22,189,248
Tennessee	10,929,830
Texas	25,278,200
*Vermont	
Virginia	9,042,015
Washington	5,273,500
Wisconsin	26,982,237
Total (24 states)	$403,030,162
Outstanding January 1, 1921	431,662,500

*No information available.

One-Sided Clauses in Public Works Specifications

Effects of Certain Contract Provisions Described in Paper Presented Jan. 14 at 23rd Annual Convention of American Road Builders Association

By R. C. MARSHALL, JR.
General Manager, Associated General Contractors of America

The opinion of contractors concerning many of the contracts that they sign is so generally known that it needs no repetition; yet in all the discussions of this subject to which I have listened, the primary cause of their complaint seems to have been misconstrued. This is probably due in considerable degree to a careless use of the term unfair, whereas the provisions commonly criticized are scored on the grounds of ambiguity or the injection of unnecessary hazard and indeterminate elements of cost.

While there are instances in which a public department or private owner, usually assisted by legal counsel, has not hesitated to deal to contractors from the bottom of the pack, these cases should not reflect upon the great majority of engineers whose instinct is to deal fairly. It is but natural that frequent use of the word unfair has annoyed the engineering profession considerably in discussion of its contracts, and has succeeded in beclouding the effect of certain contract provisions on cost and business management. Probably the best thing that can happen for all elements concerned in this important matter of contracts, is to forget the term unfair and to investigate more carefully a few economic principles which the construction industry generally seems to have overlooked.

Before touching specifically upon the effects of certain contract provisions in common use, I should like to mention briefly what appears to be one reason for their apparently haphazard development and the reason also for much unnecessary friction and conflict within the industry.

One Reason for Haphazard Development of Contract.—Although construction is probably the oldest as well as the largest industry next to agriculture and carries almost as great a responsibility for the nation's well being, economists as well as those directly interested have developed little data on its special economic problems. Only since the War, has it been recognized as an industry whose business cycle wields a mighty influence toward the stabilization of other industries when those industries are floundering in a general business depression.

In spite of its annual output of between five and eight billion dollars, about the only time that this industry has moved into focal range of the press or the public has been when it served as a political foot ball or hatched out one of its scandals. Even at these times, it has received but little analytical study except from the angle of political expediency. Its problems and practices have generally been dismissed from the public mind, and in fact, often from the engineering mind, with the assumption that the business of construction is a black sheep and never can change its color. Such impressions are due almost entirely to ignorance of the business end of this industry and one of those factors which have contributed to its delinquency.

Literature on Construction Economics.—I have never seen a book on construction economics or administration that would give the young engineer an insight into the business intricacies of the industry with which he must deal or which would point out to him those basic principles of economics which are so essential to his successful administration of construction contracts. Our technical libraries are loaded with volumes on design, which are, of course, indispensible to that minority which becomes technicians; but for the majority of young engineers who eventually move into executive or administrative positions, the library shelves are bare. Since many of them go either directly or eventually into a construction organization, this matter is of concern to contractors as well as to the professions.

Though the lack of necessary training may be due directly to the failure of engineering facilities to perceive the need of the engineering professions and the construction business, one cannot help feel that the major fault has been with these two elements themselves. In so far as I know they have never crystallized their opinions and given to the universities the

benefits of an authoritative expression of their needs. It appears also that the engineering profession itself has not kept abreast with the economics of the construction industry or that it generally realizes how inseparably it is linked with the other elements in the responsibility for proper development of methods and trade practices and for the cost of construction. By this I do not mean to imply that contractors, manufacturers, dealers and the bonding companies have kept abreast, for we all seem guilty of the charge of gross neglect. What I do mean to impress though is that no one element of the many who are concerned in construction can clean the Aegean Stable of this industry without assistance.

Three Subjects That Need Attention.—From the general contractors point of view, the industry has what might be called three pernicious triplets, all of which are in need of expert attention. They are the lien law, the bond situation and day labor. None of their afflictions were brought on by responsible contractors and they cannot be cured by his hand alone.

A well known engineer said not long ago that as soon as the responsible contractors of the country got rid of the irresponsible contractors in the industry, he would like to adopt arbitration. But with the lien law and the surety bond establishing automatic credit for any man who desires to call himself a general contractor, it is likely that we will not obtain arbitration under that engineer for a long time.

Another engineer out in the northwest told the president of our association that if the surety companies did not stop bonding irresponsible concerns his department would be forced to resort to day labor. Obviously these things are a matter of concern to all elements of the industry.

A short time ago the material dealers national association adopted a resolution that all cement should be distributed 100 per cent through dealers, thus implying that wholesale prices to the public bodies and other large purchasers should be discontinued. In other words, the dealer should obtain a commission on any cement used in his locality whether it passes through his hands or not. These are a few of the many conditions in which every one who lives by the construction industry should give some thought. There are many others, also into which we all can well afford to take an interest.

To revert back to the question of contracts, it seems to me that as long as the work under a specific contract is clearly defined and the parties to the contract are of one mind as to what shall be done and how it shall be paid for, the question of fairness ceases to exist. The trouble is that this condition does not obtain on far too many construction contracts.

A Common Fault in Quantity Estimates.—State highway specifications usually set up an estimate of quantities by which the contractor determines his overhead costs and to which at so much per unit these costs must be distributed. If some of the units are omitted, the overhead assigned to them is left uncovered and stands as an uncompensated expense of the work. Yet most specifications provide that the department without making any adjustment whatever, has the right to increase or diminish these quantities or leave out any portion of them altogether. Obviously a material reduction of quantities or even an extension of the work if prices are rising, change the actual unit cost of the work. Thus the contractor builds something different from what he was led to believe he would build and in effect the original basis of the contract is altered. This the courts have so held repeatedly where increase or decrease of quantities are excessive, and it may be added more than ten per cent may often be interpreted as excessive.

There is no question but what these changes must be made on occasion, and some proper provision therefore should be included in the contract, otherwise the bidder can protect himself only by charging his overhead to those units most likely to remain constant, thus unbalancing his bid or by adding an item of contingent expense in his estimate. Since changes must be made, since court interpretation of these unlimited right of change clauses is quite clear and since they add an item of cost to the work it might be well to eliminate them in favor of a more scientific provision. In a few contracts this question has been handled by giving the department a right to change the quantity of the work up to, say five per cent, without change of price, and by having the bidder state unit prices in his proposal for other percentages of change. This plan I am advised has been tried successfully by a number of engineers.

Penalty Clauses in Contracts.—The effect of so-called drastic contract provision upon the actual cost of a construction project does not seem to be very generally appreciated. By a drastic clause is not meant one which provides swift and sure penalty for violation of contract, but one which makes impossible an accurate estimate of cost, which tends to conceal elements of cost from a bidder, or which makes acceptance of the other contracting party's opinion a condition precedent to payment. These clauses appear to have grown out of a perfectly natural desire of the owner and his representatives to be protected against every possibility of loss until their project is delivered complete and unencumbered.

No one can justly blame them for wanting this protection, but it should be apparent that this assurance in connection with a construction project, dependent as it is upon so many uncertain factors, actually involves a significant item of cost. When a contractor guarantees a structure against acts of God, and all other contingencies of construction, he has underwritten about the worst risk to be found in industry. No insurance company will underwrite it and he must carry it himself.

Some of these hazards can be more cheaply assumed by the owner than the contractor and the insurance premium eliminated from the cost of construction. I presume that one reason why this is not generally done is that we have always with us a supply of individuals who will gamble at anything and frequently the owner can find a bidder who attempts to conduct an insurance business without collecting a premium.

How Drastic Provisions Effect Cost.—In general these so-called drastic provisions effect the cost of construction in three ways:

First, by introducing hazards or uncertainty of requirements which the construction company cannot estimate and must, therefore, be covered by a contingency charge.

Second, by restricting competition, and third, by actually increasing the cost of operations through specifying unattainable perfection or increasing the financing charges of the work by heavy retainages or delayed payment. A few examples will serve to show that the effects mentioned are real and not illusionary. As a clear example of introducing unnecessary hazard a quotation from the general conditions of the standard contract of the American Railway Engineering Association will serve. This clause states that:

"Should any work or material be required, which is not denoted in the specifications or plans, either directly or indirectly, but which is, nevertheless, necessary for the proper carrying out of the intent thereof, the contractor is to understand the same to be implied and required and shall perform all such work and furnish any such material as fully as if they were particularly delineated or described."

Another good example found in various state highway contracts reads as follows:

"The engineer may, by written notice to that effect, suspend all or any portion of the work if, in his judgment, the same cannot be properly done for any reason beyond the control of the Contractor, but no allowance of any kind will be made for such suspension except an extension of time for the completion of work."

These clauses and others of similar nature are accompanied by a clause giving the engineer (in effect one party to the contract) final decision in all matters of disagreement. The possibility of extra cost which cannot be foreseen or estimated by the construction company under such provisions is obvious. Of course, where it is possible to sue the state, and the amount of money involved is sufficient to warrant legal action, the contractor can recover in spite of this clause if he has sufficient cause. But some states cannot be sued. Often the amount involved would merely pay the attorney's fees and consequently the construction company charges it up to profit and loss. Any contractor who does not put in his bid some sort of contingency allowance for these provisions, is ignoring the most elementary principle of sound business.

It is difficult for a bidder who knows his operating costs, and knows also the cost of insuring owners against acts of God and other contingencies, to believe that the clauses here mentioned are not a premeditated effort to get something for nothing. In a measure, perhaps, they are—not that a department expects to get units of work without cost, but that it seeks a protection which should be underwritten by Lloyds of London, yet fails to perceive that premiums therefore must be charged as an element of cost.

Construction Too Much a Battle of Wits.—A tendency of this condition has been to make of construction too much a battle of wits and not enough the rendering of service under reasonable hazard at a reasonable profit. Forty per cent of the corporations engaged in construction in 1923 made no net income, according to the income tax department, and for those who made a profit the average was about 2.1 per cent. This condition, which is due greatly to excessive hazards, benefits neither the industry nor the public.

On occasion the insurance premium to cover contingencies may be forgotten or crowded out of an estimate by ignorant bidding, but there has yet been devised no way whereby a department can recover the loss occasioned by inadequate competition. Competition may be lost either by making contracts too drastic or by using clauses which make it impossible for many bidders to undertake the contract.

I have no specific contract to quote in this instance, though I have seen many of them which automatically reduced the number of bidders. This can be done by requiring commencement of the work within specified time. I know of a certain project on the Mississippi River where such a provision stipulating thirty days eliminated all of the contractors on the west coast, some of whom were anxious to bid on the project.

When a contract contains a date of completion with penalty, the date of commencement is of little practical value. In the first place, commencement may be superficial yet legal

and in the second place, it is practically impossible to determine when the work is actually commenced. Assuming that commencement can be clearly defined and determined, there is still the possibility that the limit set will exclude any bidder, however suitable, who cannot release equipment on some other project for thirty-five, sixty or ninety days. A more rational procedure would be to eliminate the date of commencement and hold to the necessary rate of progress for a specified date of completion.

Increasing Direct Construction Expenses.—Probably the most outstanding effect on cost to be noted, is that of increasing the direct construction expense. An example from the Federal Government will show how this occurs. One of the Departments had a project, estimated to cost about two million dollars and after extensive advertising, they received but two proposals. As this department had signified its intention of departing from day labor, the Associated General Contractors exerted its efforts to interest contractors all over the western states in this project. Many of them said that they would bid unless the contract form was found to contain a joker

Unfortunately, the contract did contain a joker, which prevented many firms from submitting a proposal The trouble was in the payment clauses. An analysis which one of the companies gave to me indicated that by reason of terms of payment, it would be necessary for a contractor to have something like eight hundred thousand dollars of his own money tied up in this two million dollar project before it was completed. These provisions automatically eliminated a great number of bidders who could have handled the project satisfactorily under usual terms of payment. Not only that, but the clauses used injected into the work an unnecessarily heavy item of interest.

Retained Percentages.—Some of the State Highway Specifications hold back 15 and 20 per cent as a retainer, which merely adds an unnecessary item of interest and reduces the number of marginal bidders capable of handling the project. I do not say that this always reduces the number who think they are capable of handling the project, because hope springs eternal in the contractor, and the more inexperienced he is, the further it springs.

Heavy retainages seem to be of little practical value, since they are not large at a time when a dishonest concern is most apt to default, and often brings on default by increasing the financing problem of the contractor at a time when his other difficulties are at a maximum. The policy of reducing the retainage when it progresses satisfactorily, has, I believe, been thoroughly justified by the experience of those departments that have tried it.

Arbitration of Disputes.—In any discussion of contracts it is difficult to keep from drifting more or less deeply into the matter of arbitration, as it effects vitally the attitude of the contracting parties toward each other as well as the character of construction service. I will not go deeply into the pros and cons, but I hope that all parties concerned in the construction industry will give this subject more analytical study in the future, as it offers great possibilities in removing much of the friction encountered by the various elements of industry in their transactions with each other.

In our office are on file a great many subcontract forms used by members of the Associated General Contractors, practically all of which contain an arbitration clause. This clause was not put in at the instance of subcontractors who demanded a means of impartial determination, but was put in by the general contractors themselves who realized the benefits to both parties. It is possible that the engineering profession, like architectural professions and contractors will, upon further study, arrive at the same conclusion.

Construction is, I believe, the only industry in the United States wherein the purchaser is generally opposed to arbitration. This may or may not be significant, but I believe it is one indication of why the construction industry is struggling with business practices and economic problems that have long ago been solved by other industries. Those industries have ceased to debate as to whether an arbitration clause between buyer and seller is advisable and have turned their attention to the necessary means of enforcing arbitration awards where such means are not already provided by law.

At the last session of Congress, a federal law was enacted to make enforceable written agreements to arbitrate disputes arising out of contracts, maritime transactions or commerce among the states or with foreign nations. Similar laws suitable to state needs have been passed by New York, New Jersey, Oregon and Massachusetts, with other states likely to follow.

In the discussions on arbitration that have come to my attention, it seems to have been assumed that the agreement to arbitrate is something which acts purely in favor of the general contractor and is something that the other party to the contract more or less give him as a present. No conception could be farther from the actual truth. Arbitration when properly written into a contract gives the contractor nothing that it does not give the owner and it strengthens immeasurable the hand of the engineer.

I believe there is no greater evidence to the need of arbitration than that given by the enormous record of law suits in construction. In a

vast majority of these, the decision has favored the contractor. Often the contractor has won on a technicality that would never have been countenanced by an arbitration board drawn from within the industry. The man who is acting in bad faith will invariably seek the court with competent counsel in preference to seeking arbitration.

These points, however, do not represent in the judgment of those who have tried it most thoroughly, the principal value of an arbitration clause. The American Institute of Architects which has long used such a clause in its standard contract and would not think of doing otherwise. Its representatives on the Joint Conference on Standard Construction Contracts indicated that the Institute would not participate in the Conference if it proposed to draw up a contract form without provision for arbitration. This they considered a backward step which would have destroyed the work done within their society throughout nearly a generation.

The form of arbitration contained in the Conference Document and that which is most widely favored gives the engineer full authority as to the result to be produced and the same control of the work that he has always had and merely provides that disputes involving extension of time or compensation in accordance with the terms of the contract shall be settled by agreement or arbitration. The greatest value of such a provision is not in its actual exercise to determine monetary awards, but in its effect upon the attitude for the contracting parties. Its chief influence is to prevent the assumption of hasty or arbitrary stands from which neither party will willingly retract, and to bring about agreements which are mutually satisfactory without resort to legal action. The representatives of the American Institute stated before the Joint Conference that in their opinion, it not only eliminated in most cases the need of litigation, but also the need for arbitration itself.

On the contracting side of the fence, we look forward hopefully to the establishment, not only of arbitration, but also more standardized contracts in general, which will gradually build up a sound and enforceable code of contracting practice. We believe they will facilitate interstate competition, decrease disputes and litigation and tend to make it more difficult for any dishonest concern to continue operations.

Before concluding, I should like to emphasize one other point which concerns yet transcends the subject of contracts.

Limitations on a Contract.—As one considers the record of defaulted contracts, particularly in highway work, it seems very likely that both engineers and contractors have not perceived the limitations of a legal contract. By this I mean there seems to be a feeling that if a contract is sufficiently airtight for one party or the other, that party has protected itself in every possible way. Yet if we consider the matter carefully, we realize that no form of contract can produce a high grade of work and honest performance from a low grade contractor who is dishonest.

Instances are innumerable where projects have been awarded to contractors with full knowledge that they could not perform the work satisfactorily and would eventually default. The evils of such procedure and the trouble it has caused from one end of the country to the other are too generally known to bear repetition. It is a procedure which no sane man would follow in buying a suit of clothes.

This is not offered as a criticism of engineers, because we all know what the engineer in charge of public construction is up against in awarding contracts. Until he receives sufficient support from the responsible element of every group concerned in construction and until these groups make it is their business to see that the engineer with the courage of his conviction is not made the victim of political expediency, they must suffer the consequences. I am only mentioning the subject because there is now a ray of hope discernable for its correction.

Joint Conferences.—In the last few years, we have witnessed an innovation in construction industry in the form of joint conferences and discussions between the various groups. At times we almost tire of the words "Co-operation" and "Conference," but these gatherings are gradually leading us toward a real understanding of construction and the means for its proper development. Practically every one of the conferences is developing information that has never been placed in written form and made available to those concerned. The members of these conferences are actually engaged in original study of construction economics.

Fortunately, the thought is spreading through the industry that dishonest or incompetent concerns should not be allowed to disrupt or plunder public construction and corrective measures within the industry are taking form. A practical means of exercising intelligent selection of bidders and of knowing their qualifications has been devised by the Joint Conference on Standard Construction Practices. This Conference, composed of committees from nine national associations, has issued a standard form of questionnaire and financial statement for investigating the qualifications of bidders. It has been officially approved by the American Association of State Highway Officials, and those who have developed the plan feel that its use will go far in elevating standards of performance within the industry.

Cost Analysis of Snow Removal in Michigan

Results of a Condition Survey Given in a Paper Presented Jan. 14 at 23rd Annual Meeting of the American Road Builders Association

By V. R. BURTON

Engineer on Special Assessments, Michigan State Highway Department

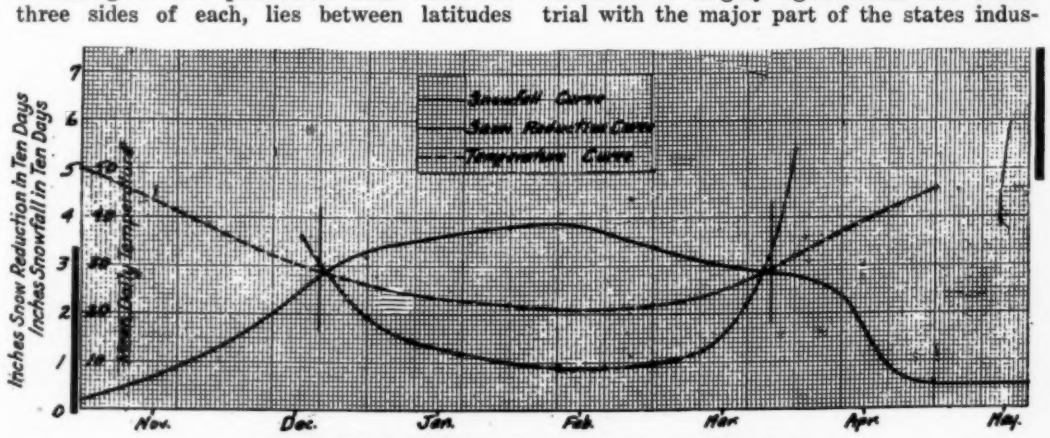
In order to understand why a snow removal survey as complete as that undertaken by Michigan was desirable, some knowledge of the conditions influencing removal is necessary.

General Situation in the State.—Michigan, consisting of two peninsulas with water on three sides of each, lies between latitudes 41° 45′ N., about that of the northernmost tip of Maine to 47° 30′ N., which is about that of Providence, R. I. The airplane distance from Monroe in the southeast corner of the Lower Peninsula to Ironwood in the western corner of the Upper Peninsula, is about 475 miles.

As can well be imagined, a state spread over a territory of this extent experiences a variation in temperature and snowfall seen in few others except where such variation is due to changes in altitude in mountainous territory. The temperature rarely goes below 5° to 10° below zero in Monroe while temperatures in the interior of the Upper Peninsula frequently reach 40° or 50° below. At Monroe about a 30 in. snowfall is usual whereas the Calumet average is 130 in.

Topography varies quite as widely. All variation of glacial topography occur from the flat fertile clay beds of the ancient glacial lakes and the sandy barren outwash plains to rough and hilly moraines. In the western end of the Upper Peninsula besides all variations of glacial topography are high, rocky hills which in some states would be dignified by the title of mountain.

The southern two-thirds of the Lower Peninsula is largely agricultural and industrial with the major part of the states indus-



Method of Estimating Snow Removal Period at Lansing, Mich.

tries grouped in the southeast quarter of this territory. The northern third of the Lower Peninsula consists largely of cutover timber land, some agricultural land and a little timber. This territory does now, and must for some time in the future, depend largely on its recreational features for its support.

The eastern end of the Upper Peninsula is agricultural and timber land. The western end is a mining and timber territory.

In the mining territory along any particular range will be found small highly industrialized regions with large stretches of wild land between.

Snow removal is practiced on practically all of the state's trunk line roads in the lower half of the southern peninsula, some removal is done in the south half of the northern half and none in the northern half of the northern half of the lower peninsula. Wheeled traffic

is maintained between certain mining towns in the western half of the upper peninsula.

An Ever Expanding Snow Removal Demand.—That is, as briefly as possible, the situation as it exists today, but this situation is rapidly changing. We are confronted with an ever expanding snow removal program. As the timber in the northern part of the state disappears leaving the raw cutover land in its wake, it is an economic impossibility for the branch line railroads to continue service. Line after line is being torn up and the territory served by these branches is being left with no means of transport, but the highway. Add to this the extension of hard surfaced roads northward, largely for summer traffic, a growing population serving the needs of our summer visitors and a developing agriculture and it requires little imagination to predict the outcome. In a short time, motor traffic must

Effective Use of Picket Snow Fence for Preventing Drifting on Highway.

and will be maintained over a large area not even considered at present.

Each year the highway department in Michigan is flooded with requests for more open roads and it became an absolute necessity for us to be able to make some reasonable estimate of the cost of the work requested and equipment required to perform it. The snow removal program of 1924-25 included 2,571 miles, 1925-26 3,024 miles and it is highly probable that 1926-27 will reach a total of around 3,500 miles.

The work added each year is in a territory in which conditions vary greatly and in which work has never before been done. There are, therefore, no cost records available for budget estimates in the territory to be considered for future removal. The only records which we do have which could possibly be of value are the U. S. Weather Bureau records of temperature, snowfalls, wind, etc., for the stations in the country involved.

Of the climatic factors affecting snow removal, temperature and snowfall are inseparably linked. It is quite evident that snow falling in the higher temperatures will not drift as badly as at lower temperatures. On the other hand, it must be equally plain that a foot of wet, soggy snow is more difficult to move than an equal amount of the light, crystalline material met at the lower temperatures. Again—snow falling at the higher temperatures may not drift enough so that removal of the smaller snowfalls is necessary at all.

In an earlier article on snow removal, it was shown that by means of the amount of snow reduction in the 48 hours including and succeeding a storm of fairly accurate estimate of the amount of snow actually moved and the length of the snow removal period could be made. This of course refers to the average condition over a long period of years, as only these station reports of 10 years and longer were used in the computation of these averages.

How Snow Removal Period Is Estimated.—This method of estimating the length of snow removal period is shown in the accompanying diagram for Lansing. The abscissae are 10 day periods in 30 day months and the ordinates are platted for each 10 day period. The difference between the ordinates of the snowfall and snow reduction curve gives the amount of snow remaining on the ground for 48 hours for each 10 day period. It is assumed that this snow is what is actually moved during the removal period. The period is shown to begin on Dec. 5, and end on March 10. This corresponds very closely to observed facts.

This method is applicable over the entire state for snow falling unaffected by the wind, and it is, therefore, possible to compare on this basis, widely different sections by the number of inches of snow per mile to be moved. If now, we compare unit cost of inch mile snow removal using in our comparison the various factors which produce cost variations over quiet snowfall, we can assign varying unit costs to take into account these different factors. To get a truly accurate idea of these varying unit costs, cost records for a number of years sufficient to insure comparison for average climatic conditions should be had.

The territory served and methods used have been changing so rapidly in this state that the only dependable cost record which we have is for the winter of 1924-25. Unfortunately this year in Michigan was an unusual year characterized by January and February temperatures from 2 to 6° below normal and a snowfall from 12 to 60 in. below normal. It is therefore, admitted that the following cost analysis should be looked on with considerable suspicion if it is intended to be used as a

basis for future prediction. As has been intimated before, the application of any one year's costs to the average is a dangerous procedure anyway. Our excuse must be that it is all we have.

In considering conditions for a single year the method outlined for the average is inapplicable. Each storm must be considered in applying the reduction and the snow determined by the actual performance of the maintenance forces. The mean temperatures in order to be comparable, however, should be determined by the more theoretical considerations of when the removal period should have begun and ended.

Cost Analysis of Snow Removal.—The factors considered in the accompanying table of cost analysis were first temperature, second wind direction and third topography. That the cost per inch mile of snow removal varies also with the snowfall is true, but enough cases were not available to bring out this variation in detail except as shown in the table. These figures are derived from a cost computation over the entire 1924-25 winter system.

Each trunk line road across an entire country was considered a unit in most cases, and the average removable snow, temperature, wind direction and topography applied to this road. Trunk Line lengths across Michigan counties will average about twenty-five miles. There will be large variations from the average of the factors considered in even this short distance in the Upper Peninsula and therefore in some Upper Peninsula Counties the distance was reduced.

The cost per mile for each trunk line road in the country was computed from the cost records of the individual maintenance sections. The cost of snow fence is assumed to be a 2 per cent depreciation charge plus the labor of erection and dismantling. There is unquestionably a great difference in the efficiency of the organizations doing this work which is reflected in cost but the more glaring examples which were known to us have been eliminated and the others compensated for in the second part of the table.

The amount of removable snow was determined by snowfall records, temperature records and the dates on which our records show plows to have been used. The reduction secured from the reduction curve showed only from 1 to 6 in. reduction during the removal period. The snow which fell before and after plows were used varied from 1 to 30 in., in a total annual snowfall of from 25 to 60 in.

From the amount of removable snow and the cost per mile the inch mile costs were made up. These costs were grouped into four tem-

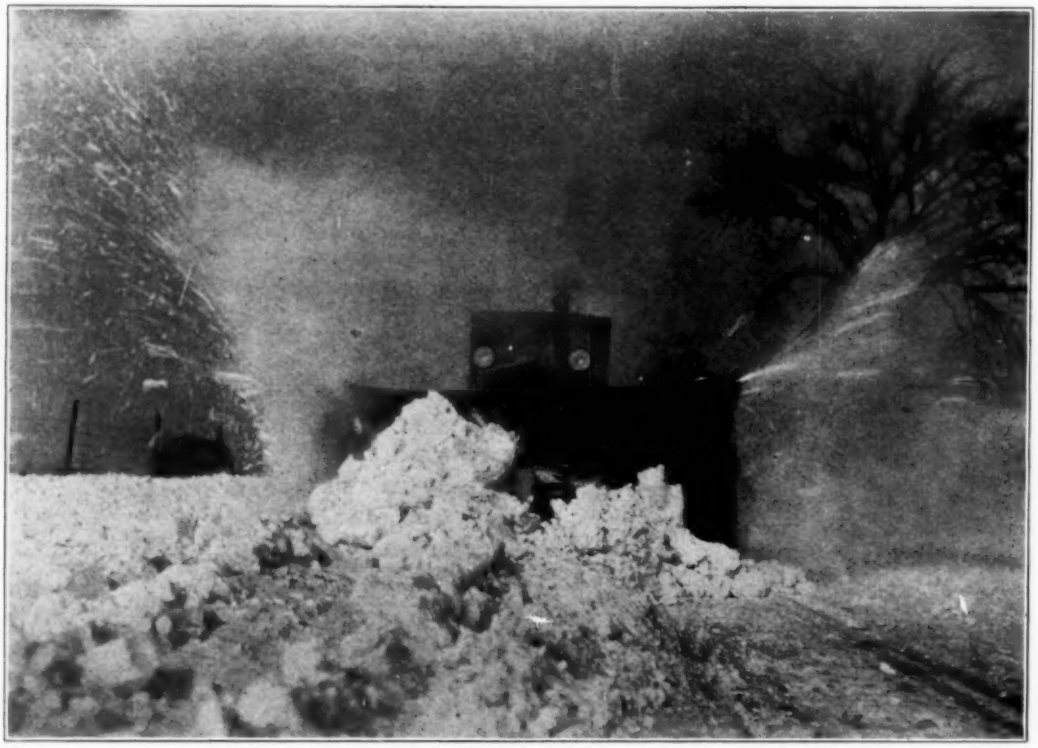
ANALYSIS OF SNOW REMOVAL COSTS
Winter 1924-1925.

Number of Counties studied	Mean temperature during removal period.	Inches removable snow variation.		TOPOGRAPHY											
				FLAT			GENTLY ROLLING			ROLLING			HILLY		
				Direction of Wind			Direction of Wind			Direction of Wind			Direction of Wind		
				// to ½	½	½ to x	// to ½	½	½ to x	// to ½	½	½ to x	// to ½	½	½ to x
				Actual Schedule of Unit Costs											
			Average												
			Inch mile cost		1.45										3.20
6	Below 18°	30-60	% of ½ wind		100										100
			No. cases		2										10
			Average												
			Inch mile cost	1.74	1.92	2.61	1.60	1.85	2.86	1.66	2.29	2.13			
11	18°-20°	7-20	% of ½ wind	91	100	136	87	100	155	73	100	93			
			No. cases	1	4	4	3	5	5	1	4	4			
			Average												
			Inch mile cost	1.25	1.33	2.28	0.69	0.69	0.56	0.57	0.81	0.97			
17	20°-22°	7-20	% of ½ wind	94	100	171	100	100	81	70	100	120			
			No. cases	5	6	2	5	7	1	4	4	6			
			Average												
			Inch mile cost	2.81	3.93	4.32		2.48	2.97	2.54	2.00	2.79			
8	22°-25°	5-30	% of ½ wind	72	100	110		100	112	127	100	140			
			No. cases	2	2	3		4	1	1	4	1			
			Possible Schedule of Unit Costs												
			Average												
			Inch mile cost		2.00										3.50
6	Below 18°	30-60	% of ½ wind		100										100
			Average												
			Inch mile cost	1.70	1.90	2.65	1.70	1.90	2.65	1.70	2.10	2.50			
11	18°-20°	7-20	% of ½ wind	90	100	140	90	100	140	80	100	120			
			Average												
			Inch mile cost	1.25	1.40	2.00	0.60	0.75	0.90	0.65	0.80	0.95			
17	20°-22°	7-20	% of ½ wind	90	100	140	80	100	120	80	100	120			
			Average												
			Inch mile cost	2.70	3.00	4.20	2.00	2.50	3.00	1.80	2.00	2.80			
8	22°-25°	5-30	% of ½ wind	90	100	140	80	100	120	90	100	140			

perature ranges, first those which occur in sections which had a mean temperature during the removal period of less than 18°. This includes all but one Upper Peninsula County. The second classification was from 18° to 20°, third from 20° to 22° and four from 22° to 25°.

Topography is classified as flat, which included the glacier lake beds and outwash plains, gently rolling the till plains; rolling the moraines and hilly the heavy moraines and rocky outcrops. This classification is admittedly vague and over as long a stretch as 25 miles subject to considerable variation. The predominating classification is used parallel to quartering and quartering to cross. Assuming 30 degree divisions of the quadrants for this classifications. This information was secured from weather bureau reports of prevailing wind direction during the snow removal period.

Two tables are shown in the cost analysis, first the actual schedule of average unit costs and second a table of possible unit costs weighted both according to the number of cases to be had and from personal knowledge of the class of work done in each case. This weighting was done to give a more consistent arrangement of percentage variations. It will



Rotary Plow Widening Cut After Truck Removal in Center.

however, and is in most cases, sufficiently accurate when dealing with so many large variables.

Culture has not been considered as important as it should be put in those countries from 20° to 25° included in the cost analysis the flat and gently rolling land is largely cultivated land. There is a larger proportion of wooded land in the rolling land. In the counties below 18° the country is generally more wooded especially the two flat stretches noted. Conditions among counties in the same temperature classification are in general quite similar.

Wind direction is given as quartering, be seen on comparison with the actual costs that this re-arrangement has been done without too serious mishandling of the actual costs.

Discussion of the Cost Analysis.—In discussing this cost analysis it should first be stated that except for the range of snowfall shown as below 18° there seemed to be little or no relation between the amount of snowfall and inch mile costs over the range covered. That is, in a number of cases it cost just as much per inch to move 30 in. as it did to move 5. Above the 30 in. and with temperatures below 18° however, there is an apparent increase in cost as the amount increases. Due to the

fact that in some cases the class of service was not comparable, for the present at least, only the averages will be used.

We should naturally expect that the inch mile cost should increase with the snowfall and if the costs of the next higher temperature classification are compared this is found to be the case. This is due to two reasons, first there begins to be at about a 30 in. amount of removable snow, a much more general use of tractor plows and these are more expensive units to operate than the trucks used for smaller amounts. Second, as the winter goes on the accumulations of snow at the side is information as to relative costs. The time consumed is in general proportional to the amount of snow moved when this time and snow moved is averaged over the whole season.

While there was some overlapping of unit costs by sections near the limits of the temperature division chosen, yet the general run of individual costs was quite consistent, really surprisingly so in the case of the 20° to 22° division. There are of course always bound to be inconsistencies due to the class of service rendered, efficiency of the organization operating, amount of traffic on the road, use or non-use of snow fence, etc., even if all our

Rear View of Rotary Widening Cut.

a more serious means of increasing the cost in the higher snowfalls, from the additional drifting caused by it and the increased difficulty of getting the snow back.

It might be assumed that the total cost of removal would vary more consistently with the number of trips made rather than with the total amount of snow moved during the season. This did not prove to be the case even though in some instances the number of trips exceeded the number of storms by 100 per cent. If the number of hours spent on the trip were taken into account they would of course be a direct index of the cost but due to variations in the time of trips, the number of trips gives little other factors were mathematically exact, which they are far from being.

The most remarkable variation in cost per inch mile is shown by the classification according to temperature. It should be remembered that this cost variation is due to the product of two factors, first the depth of drifting and second the cost of removing the particular class of snow encountered through that depth. It can easily be seen then that there may be a temperature at which a minimum cost may occur due to the minimum product and not the minimum of either factor.

Throughout all ranges of topography and wind conditions the cost per inch mile from

seventeen different counties with a mean daily temperature of 20° to 22° is consistently less than for temperatures either above or below this temperature range. Drifting is not so serious at this temperature as it is at the lower temperatures and the cost of moving an inch of drifted snow is not so high as it is in the temperatures above. We have here then the condition of snow removal at the minimum cost per inch mile.

As the temperature drops below 20° the amount of drifting increases faster than the decreased cost of moving a lighter snow and we get increased costs. The inconsistency noted in the actual schedule of the table for the flat topography below 18° is explained by a difference in culture. The two instances studied are from Upper Peninsula counties where the land is much more wooded and hence protected from drifting.

As the temperature goes above 22° the snow gets heavier and more difficult to move since thaws are much more frequent. The cost of moving this kind of snow increases faster than the decreased amount of drifting. This may seem like a rather far fetched explanation to account for these cost variations and if the roads could be kept continually clear without any interruption of service it is doubtful if so marked a difference in cost would be shown. To permit a road to fill up and then remove the parked snow after it has frozen and thawed for a day or two is a certain means of increasing costs. Increased speed of removal in these regions of higher temperature will unquestionably lower the averages given.

In one county, Monroe, with a temperature average of 25.7° and a 10 to 12 in. amount of removable snow there was some indication that the decreased amount of drifting had lowered the unit cost in spite of the increased weight of the snow but not enough data was at hand to draw any definite conclusion.

Effect of Topography on Cost of Snow Removal.—Let us now examine the effect the difference in topography on the inch mile cost of snow removal. It will be noticed that the 22° to 25° temperature range with a 5 to 30 in. variation in removable snow the cost decreases fairly uniformly from flat to rolling country. In our adjusted table this varies, using the quartering wind as a standard from $2 to $3 per inch.

In the flat country included in these counties wrom which the data on temperature range from 18 to 25° was derived, as has been stated, a majority is cultivated land. On a terrain of this character the wind gets a long clear sweep across the fields picking up the snow as it travels along the surface and deposits it at the first obstruction to its progress. This obstruction need not be any more serious than a woven wire fence especially if weeds and brush are allowed to stand along the fence row. Tighter obstacles such as picket or board fences of course increase the amount of drifting. The various rights of way of from 50 to 66 ft. do not give sufficient clearance between road and fence, and the drift forms in the roadway.

Drifts in this sort of country are characterized by only medium but very uniform depths extending for long distances along the road. There are no appreciable side slopes to absorb any of the snow accumulation or break up the sweep of the wind and the top slopes of the drift is therefore very flat throughout most of its length. These long comparatively shallow drifts are removed and the ridge accumulation along the side aggravates further drifting until before the winter is over surprisingly large amounts are on the ground.

The factors which tend to reduce the cost through this temperature and snowfall range over the more rolling country are several. First, as has been stated, especially in that part classified as rolling, more wooded land is seen. Second, where the snowfall range is no higher than it is and with temperatures this high the storage capacity of the side slopes of the larger cuts is not so often exceeded and less snow drifts in the roadway. Finally, long stretches of roadway on fills will be swept bare of any snow at all. As we pass from flat through gently rolling country to rolling there are of course all sorts of variations of these factors.

On examining the next lower temperature class from 20° to 22° the importance of the flat topography is still evident, although the cost is reduced. The gently rolling country shows the minimum cost, although between rolling and gently rolling not much difference is seen. The importance of the larger drifts in rolling country begins to be evident, however, with the increased drifting caused by the drop in temperature. The increased amount, however, does not yet overbalance the decreased cost of the lighter snow.

When the temperature drops to from 18° to 20° the increased drifting materially raises the unit costs. The larger drifts cause much more trouble, and it is now more a question of depths of snow than it is the quality. As we would expect, little difference is seen between flat and gently rolling country. The heavier cuts in the rolling country are now of somewhat more importance in their reflection of inch mile cost.

When we get into the Upper Peninsula the cuts in the rolling and hilly country are of much more relative importance and cause a serious increase in cost. These extremely bad cuts and the heavy drifts which form in them not only influence the cost from their depth

alone but, due to the rapidity with which they fill, will not permit of the continuous method of removal so essential to low costs.

Summing up the discussion of the effect of topography on snow removal cost, then, we see that from a certain temperature of minimum inch mile cost the cost increases with the roughness of the topography as the temperature falls and decrease with the roughness as it rises.

Prevailing Wind Direction as Factor in Drifting.—As was shown in a preliminary study of Michigan snow problem, the matter of wind velocity for a range in value no greater than those shown in our state is unimportant when studying a full season's work. The prevailing wind direction, however, has been found to be a more considerable factor than was at first supposed when applied to locations of similar snowfall and temperature. There are more inconsistencies, naturally, in a study of so variable a quantity because a few storms which do not come from the direction of the prevailing wind may cause trouble on a section comparatively drift free when normal winds are blowing. In general, though, where the larger number of cases are compared cost variations are fairly consistent, at least so far as sign is concerned.

The reason that the amount of snow drifting into the road varies with the direction of the winds is perfectly obvious, yet it may be well to state it. There is no less snow moving along the surface in a parallel wind than in a cross wind, but the axis of the drift is parallel to the direction of the wind. The inclination of the wind's direction to the center line of the road, then, largely determines whether or not a drift of given length will reach to the roadway. By length we mean, of course, its direction parallel to the wind.

The quartering wind is adopted as a standard of comparison, as it is much more frequently met in our state, where the prevailing winter winds are largely N.W. and S.W., quartering our section line roads. About all that we can safely say at present about these variations is that with the quartering wind as a standard it costs from 10 to 20 per cent less on those roads whose prevailing wind direction is from parallel to quartering, and 20 to 40 per cent more on those roads where this direction is from a quartering to cross wind.

Combination of Rotary and Pulled Plow to Clear Road in One Operation. Bunk House for Men and Supplies in Rear

This completes our cost analysis, and I wish to again emphasize the fact that these figures shown as possible costs are tentative. They are the only ones we have which are at all reliable, but are certain to be modified as our range of snowfall studied is increased and a sufficient number of years' records is available to bring the costs to a closer approximation to the mean. It is felt, however, that the method of comparison outlined may prove of value to those whose situation is somewhat similar to our own. It is a logical method and so far as is known is the first of its kind attempted.

Earth Road Development

Progress Report of Investigations Presented at Fifth Annual Meeting Highway Research Board

By S. S. STEINBERG
Highway Research Board, National Research Council

Highway engineers have long felt the need of a type of road surface that would serve for secondary or local traffic and yet be low in first cost and maintenance. Though considerable has been accomplished in the development of the higher type surfaces for use on main traffic roads, comparatively little progress has been made in the methods for improving secondary or natural soil roads, which constitute about 85 per cent of the total road mileage in the United States. In their present unimproved condition the local roads cannot function properly as feeders to the main routes, thus depriving considerable areas and great numbers of individuals of the benefits of those portions of our highway transportation system already completed.

In view of the enormous mileage of local roads and the comparatively small amount of traffic upon them, it is evident that for many years to come it will be economically impossible to surface all these roads with the more costly types of pavements.

Realizing this fact, the state highway departments and the universities have conducted experiments for the purpose of stabilizing and protecting the surface of earth roads. These have included soil selection methods, bituminous treatments, chemical treatments, and veneer-macadam.

Objects of Investigation.—The objects of this investigation are to coordinate the efforts and data already available on the improvement of earth roads and to stimulate further research in order to find an inexpensive road surface to carry intermediate traffic. It is recognized that no single answer to this problem would serve the entire country, but that due to differences in soil and climatic conditions the solutions will be matters affected by geography and geology. It is also felt that a proper solution may need to take into account the chemistry of the road itself, a field of research as yet untouched, but one which may help solve not only the earth road problem but also many of the subgrade difficulties encountered in the use of the more costly surfaces.

The writer's connection with this investigation has been a temporary one, and the study thus far has been preliminary and chiefly for the purpose of assembling and correlating all available information of completed, current and proposed research on earth road treatments. No field inspections have yet been made, but the material assembled will enable the investigator to study effectively in the field the experiments completed or under way in many sections of the country.

What Has Been Done.—Thus far the following work has been done:

1. Statistical material has been collected for determining the mileage of and expenditure on earth roads in the states.

2. Through the kindness of the Chief Bibliographer of the Library of Congress, and with the aid of the U. S. Bureau of Public Roads, a bibliography on earth roads and earth road treatments has been prepared.

3. A search has been made in the Patent Office of all patents granted on earth road treatments, of which about a hundred have been assembled.

4. Information has been gathered of research on earth roads now under way in various states and by universities.

5. Through the state contact men of the Highway Research Board information has been secured as to methods of earth road treatment now in use in the states.

6. By correspondence and conferences interest in the earth road problem has been aroused among highway engineers and researchers.

7. By radio talks and by articles in the press, the attention of the public has been called to the importance of the present investigation.

I desire to express to the state highway departments and to the universities my appreciation for their cooperation in the study thus far. Not only have they shown a readiness to supply all information they possess, but they have expressed a desire to be informed as to how they might contribute by research toward the success of this investigation. With such united effort the solution to this important problem cannot be far distant.

Municipal Engineers to Ask Pay Boost

A press report states that at a meeting in New York City on Dec. 22, attended by delegates from New York, Boston, Philadelphia, Chicago and Baltimore, representing municipal engineers of those cities, decided to ask pay increase of from 30 to 60 per cent. A salary of $20,000 a year or more was recommended for a chief or consulting engineer of cities of 500,000 or more. Raises of 60 per cent for the lowest paid and 30 per cent for the highest paid engineering employes were recommended.

The Economic Side of Improved Highways

Some Interesting Figures on the Savings from Surfacing Roads Given in Presidential Address Presented Jan. 12 at 23rd Annual Convention of American Road Builders Association

By WILLIAM H. CONNELL

Engineering Executive and Acting Secretary of Highways of Pennsylvania

Address by William H. Connell, Engineering Executive and Acting Secretary of Highways of Pennsylvania, President of the American Road Builders Association at the Opening of the Annual Convention at Chicago, January 12, 1926.

In the 23 years that the American Road Builders have been holding conventions, the attendance has grown from about 250 in 1903 to approximately 20,000 at the 1925 convention. This indicates the growth of this industry that now ranks as one of the biggest in the world, and when we consider that there are about 3,000,000 miles of roads in the United States and only about 430,000 miles of which are surfaced with gravel, or better, it is evident that this business is still in its infancy. While the expenditures probably will not increase in the same proportion as they have since the close of the World War, the additional mileage of hard-surfaced roads necessary to meet the highway transportation demands will result in a substantial increase in the highway expenditures each year for an indefinite time.

The Upkeep Problem Always With Us.—I say this because if the time ever arrives when all the highways will have been paved, there still will be the upkeep problem, in which is included not only the maintenance repairs, but the replacement of a considerable mileage of these pavements each year made necessary by deterioration, which is inevitable due to the wear and tear caused by the traffic. Pavements are like everything else. Their lives can be prolonged through wisely administering to their needs in the form of making the necessary repairs by applying the theory "A stitch in time saves nine," but they eventually serve their time and when the cost of repairs to keep them in proper condition to meet the traffic needs becomes so excessive that the annual charge exceeds the interest and sinking fund on the capital outlay and the maintenance cost of a new pavement, it is, of course, good business to replace the worn-out pavements with new ones. This process will go on to the end of time. Sometimes these replacements are made necessary in a shorter period of years than was anticipated due to a change in traffic conditions, but they are inevitable as it would not be sound from an economic standpoint, even if it were possible to go to the expense of building today for the next ten generations or so, as the cost would be prohibitive or it would only be possible to complete about a few hundred miles of new hard-surfaced roads each year, as compared with about 12,000 miles that were actually completed during 1925, all of which were very much needed.

The Savings from Improved Highways.—There is an accepted principle that no highway shall be constructed at a cost in excess of its earning capacity. There can be developed from the facts evolved from Transport Surveys, such as the one made in Pennsylvania, whether or not there is a definite return to the public in dollars and cents on any section of highway just as the return in dollars and cents can be shown on a section of railroad. The only difference is that the railroad's earning capacity is based on charging certain sums for transportation commodities and passengers, while the paved highway's earning capacity is based on saving definite sums to the people using the highways for transporting commodities and passengers. In the case of both the State of Pennsylvania and the entire United States the building of improved roads has saved the owners of motor vehicles many million dollars in excess of the annual costs of the roads.

About $51,750,000 annually is saved in Pennsylvania in motor vehicle operating costs as a result of the construction of 4,500 miles of hard-surfaced roads since 1911 which have replaced dirt roads on the state highway system.

Likewise, about $1,630,000,000 annually is saved in the United States in motor vehicles operating costs as a result of the construction of 133,000 miles of hard-surfaced roads and 153,000 miles of gravel roads, a total of 286,000 miles since 1904. These savings are based on 25 per cent higher operating costs on dirt

roads than on gravel roads. These figures were developed from tests that have been made. This is a very conservative basis of estimating savings inasmuch as no allowance is made for the saving in time which is a big factor, nor for the inconvenience and loss to the people dependent on dirt roads which are frequently impassable for several months of the year. In computing the saving in operating costs, an average traffic of 1,000 vehicles per day has been used for Pennsylvania and 700 for the United States, both of which are assumed to be composed of 90 per cent passenger cars and 10 per cent trucks, and the operating cost per mile of the passenger cars on the hard-surfaced roads has been assumed at 10 cts. per mile and of trucks at 36 cts. per mile, and on gravel roads at 11.4 cts. per mile for passenger cars and 40.9 cts. for trucks.

Savings Exceed Annual Cost of Improved Road.—This saving in motor vehicle operating costs, both for Pennsylvania and the entire United States, exceeds the annual cost of the improved highways. The average cost of durable type construction in Pennsylvania is about $50,000 a mile. The annual cost for each mile of road constructed, including interest and sinking fund on the capital outlay, plus the annual maintenance charge, is about $4,800 per mile, or $21,600,000 for 4,500 miles. The construction of these roads also saved the annual maintenance charge of $3,250,000 for the 4,500 miles of dirt roads which have been replaced. Therefore, the additional annual charge due to the construction is only $19,350,000. Deducting this from the saving in operating costs of $51,750,000, leaves a net annual saving of $32,400,000.

The average cost of the several types of hard-surface road construction in the United States is about $33,200 a mile and of gravel roads about $10,000 a mile, based on costs on the Federal-aid system from 1917 to 1925. The annual cost for each mile of hard-surfaced road constructed, including interest and sinking fund on the capital outlay, plus the annual maintenance charge, is about $3,350, or about $446,000,000 for 133,196 miles, for the gravel roads it is about $2,000 per mile, or $305,000,000 for 153,000 miles, making a total of $751,000,000, annual charge for the hard-surfaced and gravel roads. The maintenance costs that have been used for the different classes of roads in the United States are based on the maintenance costs for similar roads in Pennsylvania for the traffic of 700 vehicles a day that has been assumed for the United States. The construction of these roads also saved the annual maintenance charge of $143,000,000 for the 286,000 miles of dirt roads which have been replaced. Therefore, the additional annual charge due to the construction is only $608,000,000. Deducting this from the saving in operating costs of $1,630,000,000, leaves a net annual saving of $1,022,000,000.

While the owners of motor vehicles in Pennsylvania are saving $51,750,000 annually as a result of the building of 4,500 miles of hard-surfaced roads to replace dirt roads on the state highway system, they only paid to the state in 1925 $29,500,000 (to support the construction and upkeep of the entire 10,800 miles maintained by the Department) in motor vehicle registration fees and gasoline taxes, leaving them a net saving of $22,250,000.

The figures for the entire United States show that while the owners of motor vehicles save annually $1,630,000,000 in operating costs due to the construction of 280,000 miles of gravel and hard-surfaced roads, they only paid $420,000,000 in 1925 in motor vehicle registration fees and gasoline taxes leaving them a net saving of $1,210,000,000.

How Pennsylvania Is Operating.—Pennsylvania today is operating on a basis that the user pays all costs for constructing and maintaining the state highway system. Motor license receipts and the proceeds from the gasoline tax are used exclusively for highway purposes, and these funds pay the entire costs of all construction and maintenance, as well as all departmental salaries and wages—in fact, all highway expenses. New construction is financed principally by bond issues, but the interest and sinking fund charges are paid from the motor receipts.

The figures which have been stated as to the saving to the owners of motor vehicles from the construction of improved roads have definitely justified the adoption of the principle in Pennsylvania that the user should pay for the road, and when this principle has been universally accepted, the entire highway business will be on a sounder financial basis.

There is no need of my trying to impress you further with the fact that the business of this industry is going to show a very considerable increase each year because highway transportation has come to stay, unless we all take to the air. While nothing seems to be impossible, I think that you will all agree that even though there will be great progress made in aerial transportation, it will not curtail the increase in highway work each year.

Highway motor vehicle transportation is, in many instances, replacing street railway and in some cases short haul steam railway lines, and while it is my belief that it will continue to replace street railways in a great many localities, it is a form of transportation that will not seriously affect the steam railroads, but will ultimately act as a supplement or feeder to them. In the process of determining the economic field for each form of transportation,

there have been and will continue to be readjustments resulting in the abandonment of a considerable mileage of short haul steam railways, as well as electric railway lines, and likewise long distance motor vehicle transportation lines.

I have pointed out the magnitude and possibilities of the business of this industry to emphasize its serious nature and that is the reason for the existence and the success of the American Road Builders' Association.

Patching Concrete Roads

Method of Making Repairs with Cal and Portland Cement

Patching concrete roads presents problems which are so decidedly different from those met in new construction that new materials and new techniques are constantly being tried and developed to meet the demands of this type of work. By patching is meant the repair of small breaks, usually at corners or edges of the road, which may be repaired without detouring traffic. This term may also apply to repairs across the whole width of a road when the break is narrow enough to allow bridging.

After five years' experience with cal (calcium oxychloride) and its use in all classes of concrete construction, a road patching method has been developed which gives with cal and portland cement a patch which is stated to be "self curing" and to allow full traffic within 24 hours. In addition the technique is said to be so simple that good results may be obtained without expert supervision. The method is as follows:

Preliminary Work.—(1) Remove broken concrete where the patch is to be placed, and break the edges of the permanent concrete so that a fresh surface is exposed for bond with the patch. (2) Excavate the subgrade to give a total thickness of nine or ten inches to the patch. (3) Tamp the subgrade thoroughly. (4) Wet the subgrade. (5) Wet the edges of the old concrete.

Mixing the Concrete.—Using clean, dry, well graded aggregates, mix a 1:1½:3 concrete, using 8 lbs. of cal per bag of cement. Use only 5 gal. of pure mixing water per bag of cement, and mix it for 5 minutes.

Placing the Concrete.—Place the resulting dry concrete in the area to be patched and tamp thoroughly to grade. Tamp with special care at the edges of the patch where it must bond with the old concrete.

Curing.—After the patch is finished paint the exposed surfaces of the patch and the old concrete for 6 in. on all sides of the patch with a slurry of cal and water. In preparing the slurry mix 5 lb. of cal with 1 gal. of water and stir vigorously for a few minutes. This mixture is enough for 150 sq. ft. of surface. After the surface has been painted with cal the patch will not require further attention. In moderate or summer weather traffic may run over the patch in 24 hours. When the temperature is below 40° and above freezing two days should be allowed.

Cal is a powder which is added dry with the cement and aggregates. Its pure white color is insurance against an untreated batch. It can be accurately measured by volume, a gallon measure holding 8 lbs. of cal. A conscientious foreman can be trusted to see that each batch is made strictly according to the directions.

Paving Brick Manufacturers Meet

The National Paving Brick Manufacturers Association celebrated its 20th anniversary at its annual meeting at the Edgewater Beach Hotel in Chicago, Jan. 14 and 15. More than 100 manufacturers, salesmen, field engineers and superintendents were present.

The principal speakers were Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads; E. F. Kelly, chief of the Division of Tests of the U. S. Bureau of Public Roads; E. J. Mehren, vice president of the McGraw-Hill Company and former editor of Engineering News-Record and Dr. G. C. Mars, director of service of the American Face Brick Association.

The second day of the convention was devoted to group meetings of executives, field engineers and salesmen, superintendents and operating managers.

The development of paving brick of less than 3 in. in thickness was discussed in all of these group meetings. It was pointed out that brick 2½ in. in thickness were now being used on streets and highways for light and medium traffic and that pavements of this design as much as 12 years old are still in excellent condition. Where 2½ in. brick will suffice, it is needlessly expensive to lay a thicker brick.

The wide use of vitrified paving brick in gutters and for parking strips on bituminous paved streets was dwelt on. As an example of the spread of this movement it was pointed out that 3,500,000 paving brick have been used for this purpose recently in the one city of Philadelphia alone.

The association went on record as being desirous of rendering every service within its ability to assist engineers and other public officials in obtaining paving brick of the highest quality and in helping to bring about the best possible construction of brick pavements.

Winter Letting of Highway Work

Economic Advantages of Taking Bids in Fall and Winter Months Set Forth in Paper Presented Jan. 14 at 23rd Annual Convention of American Road Builders Association

By J. H. MULLEN
Vice-President, Nelson, Mullen, Nelson, Inc., Minneapolis, Minn.

One objectionable feature of road construction contracting as a business, is that for about six or seven months of the year those engaged in the business are marking time, practically doing nothing, and during the other five or six months are feverishly engaged in trying to obtain work, in preparing for it, and endeavoring to carry it through. All because the bulk of the contracts are let after the construction season opens.

Public Should Be Educated.—We know this to be so in the case of from 80 to 90 per cent of the work; but, what are we going to do about it? In my opinion, the thing to do is to get behind a movement to educate the public in these matters, and to see that the officials in charge are supported in arranging that contracts for construction are let in the fall or winter, so far as possible. And you may be sure that the highway officials will be in accord with such a move. A few of the states have inaugurated this policy, but a large number have not done so because the political situation is such that the departments cannot plan sufficiently ahead and are obliged to wait until winter time to determine their layout and make surveys and plans for the following year.

Road work is an essential industry, providing the means of primary transportation for this country, and it should be on a more substantial basis than this. By this I mean that highway departments should have, as nearly as practicable, a permanent tenure of office, free from partisan political influence, so that their programs and budgets can be made for not less than two years in advance at all times. Where such conditions exist you may be sure that work will be let sufficiently ahead of construction to allow for its economical operation.

Car Owner Has Proprietary Interest in Road Program.—When the road movement started the only people who knew or thought anything about the details of it were the highway officials, who were given a fairly free hand, and what has been accomplished under their direction is almost marvelous, both as to progress and efficiency, when you take into account the fact that this work has just gone through the early development stages. With the growth of the industry, however, comes the need for refinements and the introduction of new economies, and one economy that can be effected is the winter letting of work. But in going at this we must recognize that we have a different situation than in the early days for now nearly every person in the country who drives a car is interested, especially the financing and management of highway administration. Why is he? Because most of the financing for road construction is through motor vehicle and gas tax revenues and the car owner now feels a proprietary interest in the highway program. Therefore, the solution of this problem, which must be founded on more permanent or continuing finance and administration, will have to be brought about by publicity and education. This is essential, for otherwise our road programs may become political footballs.

Highway Construction Seasonable Operation.—Highway construction in the northern part of the United States is, of course, a seasonal operation and in more than 25 of the 48 states the period for actual construction cannot be safely figured at more than six months. In many of these states most of the road contracts are not let until after the beginning of the construction season. It is very evident that this is an uneconomical procedure, for there is a very considerable amount of preparatory work that must be done after the contracts are let which could be done to great advantage during the winter and spring months. It is, therefore, not only in the interests of economy but also with a view to stabilizing the road construction industry that highway officials, especially in the northern states, are urged to award road contracts in the fall and winter previous to construction.

Selection of Suitable Equipment.—One of the primary factors in successful road contracting is the selection of suitable equipment, for machinery enters very largely into present day methods of road building, and the fact that mechanical operation is rapidly supplanting hand labor in road building, is well exemplified by the wonderful exhibits of labor and

time-saving equipment at the road show held in connection with this convention. There are naturally some kinds of equipment more suitable and efficient than others for a given project. It is logical then that if awards are made so that the contractor knows in the winter what the nature and extent of his work will be for the following season he is more certain to deliberately study his requirements and work out his equipment organization to the best advantage.

This phase, of course, has a direct bearing on the equipment industry which has to carry heavy peaks of production and shipment due to the rush of orders resulting from late lettings. This does not facilitate the efficient operation of the equipment industry and frequently results in substitutions which are not satisfactory to the contractor or suitable for the work.

How Early Lettings Would Affect Gravel and Rock Producers.—It is estimated by the National Sand and Gravel Producers Association that in the states whose programs are affected by cold weather there was used for paving in the past year over 80,000,000 tons of sand, gravel and crushed rock. This class of material is not generally produced until after contracts for construction are awarded, and it has been the experience of every state which started a substantial program in the spring and early summer that shortage of cars and material occurred during the time that working conditions were best, which meant a serious loss in time and money. This alone warrants the early letting of contracts so that gravel and rock producing plants can be made ready and a portion of the materials produced, shipped and stock-piled. Doing so would result in reducing the cost of material, through more efficient and continuous production, and would avoid congestion and shortage of shipping facilities with its attendant expensive delays and inconvenience on the work. The producers are very positive in saying that they would be in position to give much better service and could effect substantial economies if the work were let a few months in advance of the construction season.

Effect on Contractors' Organization.—In the seasonal operation of road construction contracting it is necessary to lay off most of the employees for several months of the year. The uncertainty of the following season's work makes it unwise to hold these men, but if the work were let in the fall or winter, contractors would be able to hold their best men in line for the following year and to organize their main personnel during the winter and early spring.

All contractors have had the experience of developing an organization of reliable and efficient men which they have been unable to hold together from year to year due to the uncertainty of work, and have found when the lettings come on in the early summer that these men have been forced to seek other employment during the idle months and are not available when needed. The process is repeated every year and is costly to the contractor and detrimental to the men, who, if given continuous work with the same organization, would become more proficient in their individual lines, thereby increasing the earning capacity of themselves and their employers. This can be accomplished if plans for the next season's work are formulated well in advance of the construction.

In addition to the selection of new equipment to fit the work, the preparation of necessary materials, and engaging the nucleus of the construction organization, all of which can be facilitated by winter letting of contracts, there are a number of things which the contractor must do after obtaining the work, and which can be done, to advantage well in advance of the actual construction. Camp sites must be secured and camp buildings prepared; sidings and storage facilities when necessary must be arranged for; equipment must be transported to the work and set up; stock must be selected, and feed and other supplies located and arranged for. Such work can all be done before the working season opens and will be done better if it is not crowding the actual construction.

Effect of Early Lettings on Highway Departments.—Highway officials will generally agree that the economies herein stated can be effected by fall or winter letting of work, and those having larger programs go further, and say that early lettings make for more efficiency in the administration of their departments. It gives them the opportunity to provide for inspection and selection of materials during the winter and spring, and to organize their engineering forces early, enabling the selection of the most suitable men for resident engineers for the various classes of work to be done. It is admitted also that no matter how good the highway organization may be there are always items of preliminary work, such as right of way easements, plan revisions, etc., which are still left to be done after contracts are awarded. These tag ends, as you might call them, frequently tie up the work and cause delay and confusion which can be avoided by winter letting.

In the extreme northern states where the ground is covered with snow during most of the winter time, the work should, if possible be let in the fall, or if it is not suitable to have the lettings at that time of the year, the highway department should outline the program of construction on which awards are

to be made during the winter, early enough in the fall so that contractors or prospective bidders may have an opportunity to go over the ground to determine physical conditions before snow interferes.

It would be useless to attempt an analysis of the cost saving that might be made by advancing the time of road lettings, for this is one of those intangible things which cannot be estimated in dollars; but, in the light of 16 years of experience in charge of work on "both sides of the fence" I have no hesitancy in saying, that in the territory affected by cold weather, the letting of road contracts in the fall and winter instead of in spring and summer would result in much greater efficiency and economy.

Urban Aspects of Highway Finance Problem

Summary of Committee Report Presented at Fifth Annual Meeting of Highway Research Board

By JACOB VINER
Of the University of Chicago

As this research is still under way, the findings are tentative. On many important points the absence of the necessary statistical data limits research discovery of the problems rather than of the means to their solution.

The Contribution of Urban-Dwellers to the Financing of Rural Highways.—The contribution by urban automobile owners of a large fraction of the state motor vehicle tax revenues, the expenditure of these revenues upon the construction and maintenance of rural highways, and the absence of state contributions to the cost of construction and maintenance of urban streets, appears to involve an injustice to urban automobile owners. The problem, however, is not as serious as it appears, since traffic tests indicate that the bulk of the traffic on rural highways is urban traffic. Nevertheless, some participation of cities in the revenues from state motor vehicle taxes seems just.

Financing City Streets.—The space occupied by city streets would be needed, even in the absence of surface transportation, for purposes of access to air and sunlight, and for city ornamentation. Some proportion of the cost of pavements is properly to be charged to street railways, horse-drawn vehicles and pedestrian traffic. The bulk of the cost is now borne by real estate. Urban motor vehicle and tax revenues provide but a negligible percentage of these costs. The case for and against a transfer of a more substantial part of this cost from real estate to motor vehicle owners is being investigated.

Financial Aspects of Urban Traffic Control Problem.—The increasing financial burden on cities providing facilities for growing automobile traffic, requires coordination of traffic control policies with construction and maintenance program. Traffic congestion is an automatic but wasteful mode of traffic restriction, and it will be necessary to devise programs of restrictions in congested areas which will prevent undue congestion by restricting traffic at peak periods to economically efficient carriers. Current comparisons of efficiency in passenger transportation on basis of road-space-displacement per seated passenger are inadequate. Road-space-displacement per actual passenger-mile is a better formula. The possibility of economic control of traffic through the development of fees based on use of road space at peak periods is being considered.

How Model of California Highways Was Made

A 600-ft. panoramic relief model showing every highway in the state of California was installed recently in the Ferry Building at San Francisco. An unusual and interesting method employed in building these highways into the surface of the model, which was made of magnesite, is described in the January Highway Magazine.

A dental motor with a flexible shaft, to which was attached a small emery wheel, was used in cutting these highways into the surface of the magnesite after it had hardened over night.

After deciding on the contour of the road it was drawn on the surface of the model in chalk. Then the dental motor and emery wheel were used in cutting out the roads in the side of the mountaains and through the valleys. In order to give the proper perspective, the road is widened in the foreground (where it is about ½ in. in width) and gradually narrowed as it leads away in the distance.

The advantages of using magnesite instead of the usual plaster of paris are that the magnesite hardens over night, but is of such a texture that it can be modeled all the next day; and when it sets it is much harder than plaster of paris, and can withstand a great deal of rough handling. The magnesite is mixed with sufficient chloride crystals dissolved in water to make it set in the desired length of time.

Street Paving and Maintenance at Springfield, Mass.

Methods and Experiences in the Use of Asphalt Described in Paper Presented at Fourth Asphalt Paving Conference, Detroit, Mich., Oct. 21, 22 and 23

By WILLIAM H. WOODWARD
Superintendent Asphalt Paving, Springfield, Mass.

One city which does constant experimenting and considerable construction of asphalt pavements, is Springfield, Mass. This city builds and maintains all its streets and owns a large bituminous equipment including two asphalt plants. Evidence of the favor with which we view asphalt construction is the fact that over 100 tank cars of this material were used last year. Our experience has been quite varied and some of the methods and opinions given in this paper are the observations of many years of successes and failures in this city.

Reconditioning Old Water Bound Macadam Streets for Asphalt Surfaces.—The policy of reconditioning old water bound macadam streets as a base for asphalt surfaces is followed by many cities. That this practice is sound is demonstrated by the excellent service this type of construction has given under heavy traffic. Furthermore the economy of utilizing the present material in the street to the best advantage is very evident.

It is very seldom in city work that an old waterbound street is found in such a state as regards crown, grade and general surface condition as will allow the immediate construction of a bituminous wearing course upon it. When the finished grade may be raised and the old surface left untouched except for patching any depressions, the problem is simplified. However, more often a general reconditioning becomes necessary. Two conditions are met with; first, when the depth of the material is sufficient to allow for reconditioning and, second, where the subgrade must be excavated and the old macadam dropped in order to permit the wearing course to be to grade.

When the old water bound macadam has an adequate depth the procedure followed is first to scarify the street in such a manner as to disturb only as much material as is necessary to allow a true surface to be given it. The loose rock is reshaped by a scraper and any new material added where necessary. After this has been rolled, sand or trap rock screenings are used to make the base tight. The road is then sprinkled with water and rolled until firmly compacted. The base is ready for the wearing course.

We have experienced many instances where it is necessary to lower the subgrade and drop the old macadam to provide for a proper thickness for use of it as a base. In this case the surface is scarified to the maximum depth possible. As it is necessary to remove the material entirely and dispose of it temporarily, a number of methods are employed. Where possible, the rock is picked up by a shovel and deposited on the tree belts. If not, it is removed and teamed to an adjoining street. Sometimes half of the street is constructed at a time and the other half receives the loose material. When the old macadam has been disposed of, the exposed subgrade is lowered to allow for the desired depth of rolled base. The excavated rock is moved to its position on the subgrade and the standard method of constructing a water bound macadam pavement is followed. It might seem that this method is expensive but such is not the case as machinery performs the major part of the operation.

This type of resilient base has given excellent results on our city streets, many of which carry street car tracks. The depth of the base is at least 4 in. and such a foundation carries a wearing course either of 2½ in. of penetration macadam or 3 in. of sheet asphalt. We have some penetration streets built in this manner which are 12 years old and some sheet asphalt about 6 years old. Judging from the service these streets render, it certainly has proved good economy to utilize the old macadam streets for such a base.

Preserving Old Water Bound Macadam Street.—A satisfactory solution of the problem of saving a water bound macadam street which is in good general condition is obtained through the use of a bituminous road oil. This treatment requires that the street shall be swept clean to remove any foreign material and expose the stone in the surface. Where it is necessary to do any patching in order to bring the surface to a true shape, such repairs are made by rolling a hot mix of ½ in. stone, sand and asphalt into the depressions. The

street then receives an application of ⅛ gal. per square yard of 85% asphaltic road oil and the treatment immediately followed by a covering of coarse sand. As there is a tendency for traffic to displace any loose sand which may not have been absorbed by the asphalt, the surface is broomed once a day for at least a week.

We have treated a number of miles of residential water bound macadam streets in this manner for the last 10 years. The deterioration of the old surfaces has been stopped and these pavements now may be easily swept and flushed.

Penetration Macadam.—Our method of constructing an asphalt penetration macadam does not vary from the standard practice. However, a few months' time after each pavement is built, the new surface is swept clean, treated wih an application of ¼ gal. of 85% asphaltic road oil and covered with sharp coarse sand. A few weeks' wear under traffic irons this surface out very smooth. The purpose of this treatment is to establish a finish and tight surface which may be easily swept and flushed. One of our heavily traveled penetration streets, carrying 1,000 vehicles an hour, has received this and subsequent treatments every two or three years.

As regards the succeeding resealing of these pavements, too much stress cannot be laid upon the danger of building up a mat which will shove under heavy traffic. A resealing coat of 85% road oil is applied only after the previous coat has worn completely away.

Asphalt on Bridges.—Mention might be made here of two examples of the use of asphalt on bridges. Recently, there have been two bridges constructed in Springfield, crossing the Connecticut River, which is approximately ¼ mile in width. One of them is of concrete construction and is paved with granite blocks with an asphalt filler. The traffic is quite heavy, counts indicating a normal traffic of 15,000 vehicles a day.

The other structure is of steel construction and carries a concrete base. About 7,000 sq. yd. of standard 3-in. sheet asphalt wearing course was laid on this bridge at a cost of $1.24 a square yard. Traffic averages from 8,000 to 9,000 vehicles a day over this surface.

Penetration Base.—It has become a practice with us to construct asphalt penetration macadam as a base for sheet asphalt on highways of medium traffic leading from our city. The methods which we employ are somewhat different from the standard in as much as one course of rock is used instead of the two-course work. This single course construction has proved very satisfactory and is a decided improvement over a water bound base.

Our method is to lay on a properly built subgrade, clean coarse stone which, when rolled, is at a compacted depth of 4 in. This course is penetrated with 1¾ gal. per square yard of an 85% penetration asphalt and immediately covered by an application of 20 lbs. per square yard of ¾-in. stone. This base when well rolled is complete and ready for the sheet asphalt, comprising 1½ in. of binder and 1½ in. of top.

The point should be made that all the precautions and care taken when constructing a penetration macadam pavement are observed when building this asphalt base. As the greatest factor relied upon for stability is the interlocking of the stone, full compression is obtained until all shoving has ceased before applying the asphalt. A number of samples which have been cut from these pavements have shown the excellent manner in which the asphalt penetrates the 4-in. rock base.

Black Base.—It has been only recently that we have laid any black base in this city. The occasion arose regarding two streets in the business district where it was necessary to replace the existing pavements, one of granite block on a sand base and the other of penetration macadam, in the shortest time possible. The question of a suitable base for a sheet asphalt wearing course presented itself. The resulting delay during the curing of a concrete foundation was out of the question and then the desirable qualities of a black base became apparent.

Accordingly, the old streets were excavated to allow for a total thickness of 7½ in. of finished pavement. A mixed base was built in two courses, each 3 in. in depth, and the wearing course of 1½ in. of standard graded sheet top laid on the surface. The dispatch with which operations were concluded not only convinced us of the adaptability of this type of construction but was favorably commented upon by the business interests concerned.

Resurfacing Gravel Roads with 85% Asphaltic Road Oil.—There are various successful methods of treating gravel roads. Many of them require the use of different kinds and grades of bituminous materials. Each practice deals with local conditions such as the economic considerations, amount of traffic to be carried, equipment available, and the physical characteristics of the materials in the road.

There have been no new gravel roads built in our vicinity for a number of years. The material in them is not of the best and it has been quite a problem to maintain them, therefore, the resurfacing of them became imperative.

The method which we use consists of the application of a light priming coat followed by one of heavier material. It appears neces-

sary to employ a bitumen which has the power to penetrate and not lay upon the surface in the form of a mat. Therefore, we favor the use of an initial coat of 45% road oil followed by treatments of 85% asphaltic road oil.

The procedure of resurfacing which takes place is as follows. The surface of the road is first well scarified and then harrowed ni order to break up any lumps and bring a maximum of stone to the top. The loose material is brought to a true shape by a road scraper and firmly compacted by a roller. Water is applied to the surface and the road again rolled. After sufficient time has elapsed to allow for the drying out process, a ¼ gal. of 45% asphaltic road oil is applied. This penetrates the gravel and acts as the sizing coat for the next treatment of ⅓ gal. per square yard of 85% asphaltic road oil. A covering of coarse sand containing much gravel ranging up to ¾ in. in size is immediately thrown on and rolled until all the stones are forced into the road. Operations then cease until traffic has worked a maximum amount of sand into the asphalt. This is accomplished in about a week's time, after which any loose material is swept off and ¼ gal. of 85% asphaltic road oil is applied. The same sand and gravel coat as before is spread and then rolled. The road is opened to traffic and great care is taken for at least a week to keep sand on the surface.

The use of sand containing gravel up to ¾-in. size as a covering appears to be very desirable. The stone, when rolled into the newly applied surface, is held in place from below and becomes an integral part of the underlying gravel. Further, this covering is not only held in place on the surface by the asphalt, but also being anchored helps prevent any shoving of the bituminous material. In this manner we make use of the wearing qualities of an asphalt surface and the strength of a gravel road.

The cost of resurfacing miles of these gravel roads approximates 22 ct. a square yard. When one considers that some of this construction carries a traffic of upwards of 2,000 vehicles a day and has not been resurfaced for four years, it is adequate proof of the service rendered.

Patching Material.—It is seldom that any of our bituminous macadam pavements require patching except where there are corporation cuts and then a hot mix is used. All public utility cuts in sheet asphalt pavements are repaired with the same material as the original construction. Breaks in surface treated macadam and gravel roads are tended to with a plant mix.

A hot mix patching material which is used to maintain the edges of concrete and asphalt roads and for general purposes where there is any depth of cut, is made of 6% of an 85-100 Penertation Asphalt, 64% of ¾-in. rock and 30% of sand. Where it is necessary to patch depressions in brick pavements, general surface repairs, and anywhere a feather edge is required, a hot mix of 5% of an 85-100 Penetration Asphalt, 80% of ½-in. rock and 15% of sand is used. This mix possesses great stability and will readily flush up. During this last year 8,000 tons of these two, ¾-in. and ½-in. hot mix patching materials have gone through our plants.

We do not use cold patches except in very severe weather, and then only as a temporary repair until a more permanent patch is substituted.

California to Inspect 5,000 Culverts

The Research Department of the California Highway Commission has undertaken a comprehensive study of culverts in service throughout the state highway system. The results of this work will be made available to the Highway Research Board in connection with its investigation on culvert pipe and small drainage structures, a report on which was presented at the annual meeting of the Board on Dec. 3 and 4, 1925.

The field work in California has now been underway for four months. It is expected that field work will be completed about Feb. 1, 1926, at which time detailed inspections will have been made of at least 5,000 culverts of all types. Samples from both the top and bottom of metal pipes will be taken for analysis. Samples of the water passing through culverts also will be secured, when necessary.

The inspection will be extended to every part of the state to insure that the culvert service data secured will represent all possible conditions of climate, soil, and water. A preliminary study of several hundred culverts has indicated that much valuable information will be secured, concerning not only the normal life of culverts of various types, but the effect upon their life of location, drainage, soil conditions, and maintenance. As a result of this study it is hoped to determine definitely what service culverts are giving on the state highway system.

The investigation is being conducted under the supervision of C. L. McKesson, Research and Testing Engineer. The field work is being done by W. J. Stonebraker, assistant testing engineer, in co-operation with representatives of the division offices.

Chicago Road Convention and Show

The 1926 Meeting of the American Road Builders' Association the Most Successful Ever Held by That Organization

When last year's convention and road show closed, it seemed that a more successful convention and a greater exhibition of road building machinery would be impossible. Yet the twenty-third road show and convention of the American Road Builders' Association, held in Chicago, Jan. 11 to 15, 1926, outstripped any previous gathering of this organization. In attendance, in the number of exhibits, and in support of the convention programs, the twenty-third road show set the high water mark of demonstrated interest in highway matters.

During the week of the road show more than 35,000 men, in some way interested in road building visited Chicago and registered at the Coliseum. Every State in the Union was represented and there were delegations from 15 foreign countries. Authorities in highway building gathered to talk over their common problems and to see the latest developments in road building, road maintaining and traffic regulation equipment. Three governors and many leaders of industry, among whom was Chas. M. Schwab, attended.

The road show at the Coliseum opened its doors for a short session Monday evening, Jan. 11, and each day thereafter until Friday, Jan. 15. From 9 o'clock in the morning until 6 o'clock in the evening throngs of engineers and contractors viewed the tremendous exhibits of machinery and equipment. It is estimated that about 10,000 people visited the Coliseum each day.

As in previous years, the American Road Builders' Association assembled in convention in the Congress Hotel, Chicago, during the same week. Morning and afternoon sessions, starting on Tuesday, Jan. 12, and continuing through Thursday, January 14, gave visiting delegates an opportunity to hear national authorities speak on the many subjects of interest to road builders.

Convention Was Well Attended.—The sessions at the Congress Hotel were well attended. Probably a greater number of delegates devoted more time to attendance at the convention than in previous years.

They were well repaid, for the program committee, under the leadership of Frank T. Sheets, Chief Highway Engineer for Illinois, prepared a program of unusual interest. An innovation this year was the separation of the sessions into two sections, one for engineers and one for contractors.

Details of the Program.—President William H. Connell opened the convention with a short address at a general session on Tuesday morning at which both the engineering and the contracting sections were present. Mr. Connell reviewed some of the A. R. B. A. early history and contrasted the size of the present road show with the one held in 1903 when only 250 people attended. Other speakers in this session were Len Small, Governor of Illinois; Wm. E. Dever, Mayor of Chicago; C. H. Markham, President, Illinois Central Railroad, and David R. Forgan, Vice Chairman, The National Bank of the Republic, Chicago.

In Tuesday's afternoon sessions, the contractors and the engineers split into separate groups. Under the general heading "Making the Contracting Business Pay," the contractors had an interesting discussion. N. F. Helmers of St. Paul, Minn., spoke on "Investigation of Projects On Which You Bid." A. R. Hirst, formerly Chief Highway Engineer of Wisconsin and now Chief Engineer for the American Vibrolithic Corporation, discussed "Estimating the Job." The need for keeping intelligent cost records was pointed out by W. B. Smith of Meriden, Conn., and Col. Geo. B. Walbridge, President of the Associated General Contractors of America, had as his subject "Qualifications of the Contractor."

In Tuesday afternoon's engineering section the general subject for discussion was "Financing and Locating Highways." Thos. H. McDonald, chief of the U. S. Bureau of Roads, opened the discussion with a discourse on financing highways. W. W. Cosby, location engineer for the Pennsylvania Department of Highways, pointed out the essentials of rural highway location, and Eugene S. Taylor, manager of the Chicago Plan Commission, discussed the planning and location of arterial streets in cities. The session closed with a paper by Chas. M. Upham, director of the Highway Research Board of the National Research Council, in which he told of the work of that body.

Wednesday, January 13.—Wednesday was a busy day at the convention. In a general session, attended by both engineers and contractors in the morning, the question of "Traffic" was taken up. It was discussed from the standpoint of the State by Major Lynn G. Adams, superintendent of the Pennsylvania State Police, and from the standpoint of the city by Morgan Collins, Superintendent of

Police, Chicago. "Relation or Correlation of Various Transportation Agencies" was the title of the next paper, by T. R. Dahl, vice president of the White Motor Truck Co. The session concluded with a paper by Frank H. Alfred, president of the Pere Marquette Railroad, on "Coordination of Steam Railway and Motor Vehicle Transportation."

The afternoon session was again divided into two sections. The engineers discussed "Construction" and the contractors "Practical Operating Methods." Papers read in the engineers' section were: "Governing Factors in Selection of Durable Types of City Pavements," by C. M. Pinckney, chief engineer, Borough of Manhattan, New York City; "Recent Developments in Concrete Paving Practice," by H. E. Surman, engineer of design, Illinois Division of Highways, and "Recent Developments in Bituminous Paving Practice," by H. McCahan Rex, construction engineer, North Carolina State Highway Commission. The contractors' section listened to talks on "Increased Costs Due to Improper Fine Grading Methods," by C. J. Moritz, Effingham, Ill.; "Relative Merits of Yard Handling Materials With Derricks, Cranes, Conveyors, etc." by R. P. Petersen, Rock Island, Ill.; "Economics of Equipment Standardization," by C. H. Powell, Chicago, and "How to Stop Cement Over-Run," by R. E. O'Connor, Ft. Wayne, Ind.

Business Meeting.—Immediately after the afternoon sessions the annual business meeting of the Association was held. At this meeting a nominating committee was elected to select the officers who will guide the destinies of the A. R. B. A. in 1927-1928. As the report of the tellers was not ready and the Resolutions Committee wanted more time, the meeting was adjourned until Thursday.

Annual Banquet.—Wednesday evening the annual banquet was held in the Gold Room of the Congress Hotel. The principal speaker of the evening was Charles M. Schwab, chairman of the board, Bethlehem Steel Co., who gave a characteristic Schwab address filled with sound advice and enlivened by humor. A rapid fire talk was also given by the Reverend C. Wallace Petty, minister of the First Baptist Church of Pittsburgh. W. H. Connell, retiring president of the Association, reviewed the activities of the organization and pointed out the need for continuing that work. Wilbur D. Nesbit officiated as toastmaster.

Closing Day.—On Thursday, Jan. 14, the closing day of the convention, the order of procedure was reversed. The separated sessions were held in the morning and a general afternoon session closed the convention.

The engineers discussed "Operation and Maintenance." V. T. Burton of the Michigan State Highway Department read an interesting paper giving the results of his studies in "Snow Removal." "Gang vs. Caretaker Maintenance" was the subject of a paper by Maj. W. H. Acheson, division engineer of the New York State Department of Public Works. S. N. Mackall, chief engineer of the Maryland Highway Department spoke on "Surface Treatment of Various Types of Roads."

The contractors, in their morning session considered various means for "Enlarging the Contractor's Field." Such subjects as "Economic Reasons for Winter Letting of Road Work," "Relations Between Contractor and Sub-contractor," "Resurfacing and Maintenance Work As a Future Field for the Contractor" were discussed by J. H. Mullen of Minneapolis, C. E. Hair of Terre Haute, Ind., and G. F. Schlesinger, Director of Highways, Columbus, Ohio.

A general get-together session was held in the afternoon with the topic, "The Contractor and the Engineer" up for discussion. General R. C. Marshall, Jr., general manager of Associated General Contractors of America, spoke for the contractors on the subject, "One-Sided Clauses in Public Works Specifications." C. M. Babcock, Minnesota State Commissioner of Highways, spoke for the engineers on "Relations Between Contractor and Engineer," bringing to a close a most interesting and constructive program.

New Officers.—Henry G. Shirley, chairman of the Virginia State Highway Commission, was elected president of the A. R. B. A. He will take office in May, 1926.

Other officers elected were:

Vice president, Northeastern District—W. R. Smith, president Lane Const. Corp., Meriden, Conn.

Vice president, Southern District—S. T. Henry, director, Pan-American Confederation for Highway Education, Spruce Pine, N. C.

Vice president, Central District—S. F. Beatty, vice president, Austin-Western Road Machinery Co., Chicago.

Vice president, Western District—Samuel Hill, honorary president, Washington State Good Roads Association, Seattle, Wash.

Treasurer—James M. MacDonald, New Haven, Conn.

At the Coliseum.—More than $3,000,000 worth of road building machinery and equipment were displayed by the 300 exhibitors at the Coliseum. Every available inch of space in the Coliseum proper, its balconies, its annex and in two adjacent buildings was used. Even then exhibitors accepted cuts in the amount of space they wanted and a number of manufacturers displayed their equipment along the sidewalks in front of the Coliseum and in nearby vacant lots.

Each day, it is estimated, approximately

10,000 people visited the exhibits. Space was allotted much as in previous years with the heavy machinery on the ground floors of the Coliseum and the annex, the trucks, etc., in the adjacent buildings and the lighter exhibits in the balconies. The ball room of the Coliseum was again given over to the various material interests, publications and to the very interesting educational exhibit of the U. S. Bureau of Public Roads.

Meeting of American Engineering Council

Dean Dexter S. Kimball of Cornell University was elected president of the American Engineering Council at the annual meeting of the council at the Mayflower Hotel in Washington, Jan. 13 to 15. Dean Kimball, past president of the American Society of Mechanical Engineers, succeeds former Governor James Hartness of Vermont.

Gardner S. Williams of Ann Arbor, Mich., and Irving E. Moultrop of Boston were named vice-presidents, Mr. Williams being re-elected. Dr. Harrison E. Howe of Washington was re-elected treasurer, and Lawrence W. Wallace of Washington was again chosen executive secretary, a post he has held since the organization of the council.

The council at its Washington meeting adopted what was characterized by President Kimball as the most constructive program in the field of public service ever undertaken by the engineering profession of this country.

Approval was given to a public works bill to be introduced in the Senate by Wesley L. Jones of Washington and in the House by Adam M. Wyant of Pennsylvania. This measure, adopted by a National Public Works Conference held on January 14 under the auspices of the council, and attended by delegates from more than 70 national and local organizations, would change the name of the Department of the Interior to the Department of Public Works and Domain. Four assistant secretaries are provided for and numerous transfers to the new department of boards, bureaus, commissions and officers are made.

The council adopted the report of its patents committee urging support of Congress bills providing for the construction of a new patent office building and increases in the salaries of Federal judges.

A program for nationwide engineering effort to solve traffic problems was sanctioned following the adoption of a report of the council's committee on street and highway safety, of which W. B. Powell of Buffalo is chairman.

The National Conference on Street and Highway Safety, after its meeting in Washington in the near future, will go out of existence as a continuing body, and its work parceled out to appropriate constituent bodies.

The American Engineering Council will take over, it is planned, the engineering phases of the conference's program, dealing particularly with questions involving metropolitan traffic facilities and grade crossings.

Local engineering societies in every section of the United States, the report of the council's committee said, are assembling data out of which a definite plan to eliminate danger to life may be formed. Solution of the traffic difficulty was said to present a clear engineering problem.

The assembly of the council adopted recommendations of the administrative board declaring it "the sense of American Engineering Council that the government should not trespass upon the field of industry unless it can be satisfactorily shown that the government can better engage in that business than private enterprise can."

It was voted to postpone action on the Giant Power report until further consideration could be given to it.

An exhaustive study of the whole reclamation problem, and the adoption of a fixed policy eliminating political influence, were urged in a report of the committee on reclamation headed by Prof. H. B. Walker of the University of Kansas. The report was referred to the council's executive committee with power to act.

The Employment Service of the National Engineering Societies, it was announced at the meeting, is developing successfully. The headquarters of the service in New York has been supplemented by the establishment of branches in Chicago and San Francisco with the cooperation of the American Chemical Society.

Study of Land Slide Problems

The U. S. Bureau of Public Roads has assigned Dr. George E. Ladd, Geologist, to a study of the problems involved in land slides in West Virginia and Ohio, with particular reference to the effect of slides on road construction.

A preliminary survey has been completed in the two States. For the future it is planned to make a field study of the geographical and topographical conditions involved, and a detailed study of the different types of slide which are about equally divided between side-hill and fill slides. Possibilities of surface drainage will be investigated and field experiments will be conducted. In addition to the field work, laboratory experiments will be made on average samples of slide material from different localities.

Earth Road Maintenance

A Practical Discussion of a Much Neglected Problem in Highway Work

By CAL SIVRIGHT
General Manager Stockland Road Machinery Co.

Many highway officials frankly consider the earth road a more or less hopeless proposition. Earth roads are something to be graded, and dragged, and kept in more or less passable condition with the same treatment that has been used for years, until such time as it is possible to turn them into gravel, macadam, concrete or brick highways.

Progress in the methods used in building and maintaining earth roads has received little attention in most states, for two good reasons. First, there has been little time for such work with all the building programs that the states have undertaken, work which has required most of the time of the men in the highway departments.

Second, earth roads are being supplanted by improved roads on most principal highways which are receiving most of the attention and the appropriation for road work, and this quite properly.

However, we still have the earth roads. Money is still being spent for their maintenance. And it is hoped that the following suggestions, the result of a great deal of field experience in grader work, with collected views of earth road workers, will prove helpful.

The Hard Facts About the Earth Road Situation.—There are something more than 2,500,000 miles of earth road in the United States, which means that no large proportion of them will be surfaced within the next 20 years.

Most of this mileage of earth roads has never been properly built. These roads for the most part have never been brought to anything approaching proper grade and section.

Largely because they have never been properly built, much of the maintenance work expended upon these roads is wasted effort.

Once properly built, the less work done on an earth road the better. Frequent light maintenance serves better than intermittent heavy grader work. And yet, intermittent heavy work is more often the rule.

Quite often the work done with both drag and grader is harmful, rather than beneficial, to earth roads, according to many experienced operators.

If these five points sum up the outstanding facts in the earth road situation, and men familiar with this situation assure us that they do, surely a great economy can be realized by adhering more closely to a few fundamental principles in earth road work.

52 Years a Road—Never Been Built.—The illustration shows a typical earth road in a wealthy agricultural section of the Central West. It is one of the five main roads, all of which are in the same condition, leading into a town of 1,200 people.

This Road Has Been a Highway for 52 Years, and Yet It Has Never Been Built with Correct Drainage Ditches and Proper Section

This road has received township maintenance for a period of at least 52 years. It has had numerous "goings over" with graders and drags, but so far as the road is concerned is little better than it was 50 years ago, according to people who use it, and it is almost impassable for two to three months each year.

Practically every section of the United States can contribute such photographs. It is this treatment of earth roads that is largely responsible for the public attitude toward roads of this type.

First of all, this road has never been brought to correct section. Proper ditches have never been built. Water stands for days in

the ditches during spring rains and puddles extend over the road surface in some spots.

Work on the road has consisted of "grading up" the earth from the sides to the crown. The ditch has been simply the end of the natural crown slope.

Dragging after rains has been done in such a manner that it tended to destroy rather than preserve the crown. As a result, the road has had a great deal of money expended upon it with practically no result except the most temporary improvement immediately after the work.

Build Earth Roads First.—It cannot be too strongly emphasized to men responsible for

Large Grader on Heavy Road Construction Work

working such roads that the earth road must be properly built before maintenance work can be at all economical and effective.

Various authorities state that it takes at least two years to develop what may be called a good earth road. The first step is to bring the road to proper section with good ditches with correct gradients.

There is no need to discuss construction methods here. Many booklets and bulletins have been published on the subject and are easily available.

The First Year's Maintenance.—After an earth road has been properly constructed with good shoulders, a correctly shaped crown and well-made, back-sloped ditches, the first year's maintenance work may be fairly heavy.

The surface of the road will not be properly compacted. Traffic will naturally rut the soft surface, quite a bit of washing will occur and ditches will tend to fill with silt.

This first year's maintenance can preserve or destroy the construction work that preceded it. It must be carefully and conscientiously done.

Ditches should be kept clean and the soil from ditch cleaning carefully feathered out over the crown, used to fill ruts, etc.

The whole object of this work is to secure good compaction of the soil with proper drainage section of the road.

It is a discouraging task. If the road is allowed to rut badly, if ditches become filled with silt and shoulders allowed to wash, the work of construction is all to do over. It is this feature that has caused most earth road workers to give up the job and settle down to "just giving it a working" which means for the most part a cross between construction work and maintenance work without much of either.

However, if the soil is of such a nature that it will compact well at the end of the first

year's work, there will be less tendency for the surface to rut deeply, the shoulders will wash less, ditch cleaning can be less frequent and the road is on its way toward becoming a good earth road.

Trouble may be experienced during the next heavy rainy season. Heavy traffic and constant rain will ruin any earth road. But with a bit of heavy work after the rainy season the earth road man who has preserved his section and secured good compaction can do light maintenance work for the remainder of the time and have a good road.

Barring unusual soil conditions, it will be passable the year round. In most sections of the United States it will be an excellent road for the major portion of the year.

These suggestions are naturally only general principles. The reader should keep in mind that local soil conditions determine the possibility of success with earth roads and the length of time necessary to bring them to a point where lighter maintenance will preserve their section. Local traffic conditions and rainfall are also to be considered.

Maintaining a Correctly Built Earth Road.—After an earth road has become well compacted with correct section, the less work done on it the better. It is simply a matter of keeping ditches clean, ruts filled and preserving the crown and shoulders.

In recent years there has been a tendency to use a drag on earth roads to "puddle" the earth while it is wet, with the idea that such puddling forms a more or less impervious crust.

In some soils this has proved successful; in others the puddling is useless. In any case, the drag is securely established as a maintenance tool in earth road work.

Properly used, the drag is efficient and can in some instances make a great deal of grader work unnecessary. But most drag operators forget that the drag can be used to move earth in one direction or another. They begin on the crown, because this dries first and move the earth toward the shoulders which tends to destroy the roads section.

Patrol Grader on Maintenance Work Near St. Marys, Kan.

Another disadvantage of the drag is the unevenness of the work. The drag has no "wheel base" and follows and tends to accentuate any inequalities in the road surface.

Surface Maintenance With the Grader.—A light patrol grader seen on earth roads in many sections because of the heavy costs between maintenance and construction work done on the roads is the thing to use. In many sections, road men would actually question the

possibility of working an earth road with a light two-horse machine.

Yet, until such work is common on our earth roads, we are not giving the earth road a fair chance. There is no reason why an earth road which gets the same or heavier traffic than many gravel roads (and there are many such earth roads) should not have the same opportunity from a maintenance standpoint.

These light patrols should keep ditches cleaned, shoulders built up and ruts filled. They should be used to feather out the earth just as they feather out gravel.

Don't Move Earth Till You Need It.—The operator should keep in mind that all he is supposed to do is to preserve the road's section. He is not sent out to "move earth," as so many operators seem to think. Instead of cutting down the shoulders and piling them in a "ridge pole" in the center of the road, a loose mass of earth which will absorb the next rain and soften the road surface, causing it to rut, he should take only the lightest cuts.

This cut away earth should only be moved when it is needed. For, strange to say, the job is to get loose earth in making such cuts, not to cut it loose.

This earth is used to fill ruts, low spots, preserve the crown. If the surface is fairly level, the earth can be taken from ditches for this purpose and no cuts at all taken from the road. But this should be done only when the ditches need cleaning.

Much so-called "dressing up" of the surface of earth roads is labor lost. It simply disturbs the surface, makes it wash, promotes absorption of water and does the road no good whatsoever. Grader operators who like to see the smooth, shining surface of moist soil behind the grader blade and think this is making an earth road as "smooth as concrete" have only to wait until the next rain to see what their work has accomplished.

As one old experienced operator puts it—a man whose roads are the pride of his township: "Listen you, y'aint makin' no garden now; y're buildin' a road, so go easy."

Forest Highway Improvement.—The total mileage of forest roads improved by the U. S. Bureau of Public Roads up to the close of the fiscal year ended June 30, 1925, was 2,429 miles. The mileage completed during the last fiscal year was 681½ and the total cost $28,668,852.

Selective Control for Traffic Signals

A recent development in apparatus for traffic guidance is illustrated. The control is motor driven, direct drive, and functions through operation of a gear mechanism running in an oil bath, causing the operation of clapper type switches contained in a dust-proof housing. The mechanism consists of two cut steel hardened timing gears which are alternately driven from a constant speed shaft. Each of these two timing gears represent the time or period to be allowed traffic in one direction, that is, one represents the main traffic and the other represents the cross traffic. Each timing gear is controlled from outside of the housing by means of a hand set timing indicator, which moves over a definitely calibrated scale marked in seconds reading from 10 seconds to 150 seconds. The setting of these indicators at any definite scale causes the operation of the timing gear at the same time interval. In other words, if the cross traffic indicator is set at 30 seconds, and the main traffic indicator at 50 seconds, then the signal circuit will be on for 30 seconds on the cross street and for 50 seconds on the main street. These indicators can be set at any timing simply by the loosening of thumb screws and can be set at any of the scale readings, giving a control which allows for the changing of the timing on one street of an intersection without in any way interfering with the timing on the other street of the same intersection. Notwithstanding the flexible arrangement provided for changing the timing for main traffic or cross traffic, the caution period remains at a constant timing. This caution period is pre-determined and arranged to operate at this predetermined period when constructing the controlling equipment and does not vary. This control is a product of Essco Manufacturing Co., Peoria, Ill.

Essco Traffic Control

Gas Tax and Fees in Missouri Gives $12,500,000.—Approximately $12,500,000 for Missouri road building purposes was produced in 1925 by the new 2 cents a gallon state tax on gasoline and by state automobile registration fees.

Widening Old Concrete Pavement

Method and Cost of Laying 4 Ft. Slab Alongside Old 15 Ft. Pavement

By E. N. FLETCHER
Civil Engineer, Swiss, Mo.

In 1924 the Capitol Construction Co., of Des Moines, Ia., had a 16-mile paving contract in Illinois, highway number 12, running east and west out of O'Fallon.

The west end of this job joined an old 15 ft. pavement that had been laid in 1912, and the west end of this old pavement joined a 20 ft. pavement. This old pavement was 1½ miles long and was in good shape. In order to make it match up with the new 18 ft. pavement being laid and the new 20 ft. pavement already laid, and, as it was the main road west out of St. Louis and East St. Louis, being only 9 miles out of East St. Louis, and subject to heavy traffic, it was decided to widen it to 19 ft. by laying a 4 ft. slab along side of it. The new 4 ft slab was to be 8 in. thick and was to be reinforced with a ⅞ in. smooth steel rods on each side the same as the 18 ft. standard Illinois paving. The old slab was 7 in. thick. The two slabs were not to be tied together in any way.

As civil engineer with the company I was given the job of widening this old paving.

Cost of Aggregate.—The crushed stone and sand used were stock-piled, in advance, along the old pavement at 200 ft. intervals. They were unloaded by hand and hauled an average distance of 2 miles in Ford trucks. Four men shoveled the material into the trucks from the cars and three trucks were used to haul it. While unloading rock each truck made 15 trips a day and while unloading sand they made 20 trips a day, hauling a yard at a load. The costs were as follows:

	Per Cu. Yd.
Cost of rock f.o.b. siding	$1.80
Cost of sand f.o.b. siding	0.90
Cost of unloading and hauling sand and rock to job was:	
4 men shoveling at $0.35 per hr. for 10 hrs.	14.20
3 trucks at $1.50 per hr. for 10 hrs.	45.00
Total cost per day	59.20

The three trucks hauled 45 loads of rock in a day or 60 loads of sand.

	Per Cu. Yd.
Cost of unloading and hauling sand to job	$0.987
Cost of unloading and hauling rock to job	1.315
Total cost of sand on job	1.887
Total cost of rock on job	2.115

Cost of Cement.—The cement was furnished by the state. It was unloaded and stored at the siding and hauled to the job as needed. It was unloaded and stored for 1 ct. a sack and one large truck at $2.50 per hr. and helper at $0.35 per hr. spent an average of two hrs. a day hauling it to the job. The average amount of slab laid per day was 480 ft. or 47 cu. yds. of concrete. It required 7 sacks to the yard of concrete, or 329 sacks of cement per day.

Cost of Cement Delivered to Job

Unloading and storing 329 sacks at 1 ct. per sack	$3.29
Truck at $2.50 per hr. and helper at $0.35 per hr. for two hours	5.70
Total cost per day	$8.99
Cost of cement to contractor per cu. yd. of concrete	$0.191

Cost of Mixing, Placing and Finishing.—A one sack mixer was used and water was hauled to it in a tank wagon, the average haul was 1½ miles; 2x8 in. boards were used for forms.

The paving crew consisted of two men wheeling rock and one wheeling sand to mixer, one handling the cement and raising skip to charge mixer, one in charge of mixer, three wheeling wet concrete, two finishing, two tamping and placing concrete, two setting forms and subgrading, and one placing and painting steel and subgrading, one man and team hauling water. This crew laid an average of 480 lin. ft. of slab or 47 cu. yds. of concrete per day of 10 hours. The costs were as follows:

Daily Cost of Mixing, Placing and Finishing Concrete

1 Foreman at $7.00 per day	$ 7.00
1 Mixer operator at $5.00 per day	5.00
14 laborers at $3.50 per day	49.00
1 team hauling water, $5.50 per day	5.50
Total labor cost	$66.50
Gas 5 gal. at $5.20 per gal	$1.00
Oil 1 qt. at $0.25 per qt.	0.25
Depreciation on mixer per day	1.50
Depreciation on forms per day	0.40
Repairs, broken shovels, etc.	0.25
Total	$3.40

Total cost of mixing, placing, finishing $69.90 per day $3.40.

Summary of Costs.—In figuring depreciation for mixer we figured that if run 50 days a year that it would be worn out in four years, or 600 working days. Value of mixer was $900 which gives us a depreciation of $1.50 per day. Forms could be used again and were valued at half their cost when job was finished.

Total Cost Per Cu. Yd.

	Per Cu. Yd.
Sand—0.6 yd., allowing for waste	$1.322
Rock—0.9 yd.	1.903
Cement—Unloading, storing and hauling only	0.191
Mixing, placing and finishing	1.508
Total cost per cu. yd.	$4.924

The slab was 8 in. thick, so 1 cu. yd. of concrete will lay 4.5 sq. yds. The cost per sq. yd. therefore was $1.094.

As I stated before, this slab was not in any way tied to the old slab. I was over this road a year after it was finished. The two slabs showed no tendency to separate, except on a sharp curve. The 4 ft. slab was laid on the outside of this curve, and, although we had widened the inside of the curve 9 ft., making a total width of slab at this place of 28 ft. the 4 ft. slab had been shoved out, in the worst place, almost 2 in.

Highway Research in 1925

Some Results Obtained During Past Year Outlined in Annual Report of U. S. Bureau of Public Roads

The building of a national highway transportation system is a trust which the bureau feels can not be faithfully administered without constant effort to broaden the field of scientific knowledge of the materials and processes employed in the construction. The highway researches of a physical and economic character in which it has been engaged for a number of years are regarded, therefore as a highly important department of the work.

What the Research Covered.—During the past year the most significant results have been obtained in three branches of this work. A field study and careful analysis of the elements affecting the cost of grading and concrete paving have led to the development of managerial methods the application of which in test projects has cut costs of construction virtually in half. No more practical or immediately beneficial study has ever been made by the bureau. The second result of importance has been the development of methods of analyzing the flow of traffic over a highway system and the application of the results of such analysis to the economic improvement of the system. These methods applied in California, Maine, Connecticut, Pennsylvania, Ohio, and Cook County, Ill., have been instantly recognized by the State and local officials as a most valuable aid to administration. The third outstanding advance is that which has rewarded the prolonged study of highway subgrades. Practical methods have been devised for the identification of suitable soils, and there is reasonable ground for hope that corrective treatments will soon be developed that will make it possible to overcome the handicap of unsuitable soils.

Studies of Earth Moving Equipment.—In the analysis of construction costs the first work was a study of the operation of earth-moving equipment. Beginning with the lighter equipment, such as slip scrapers, wheelers, and fresnoes, the investigations were later extended to include the operation of elevating graders, steam shovels, drag lines, and dredges. Each type of equipment has been studied in operation with the object of determining the extent of the preventable time losses. Such losses have been detected even on well-managed projects, their presence wholly unsuspected by the contractor because of the lack of a detailed study of the operations involved in the work. Once detected it is a comparatively simple matter to eliminate them by careful management; and the tests made indicate that savings of from 25 to 35 per cent of the earth-moving cost may generally be made on average projects.

Concrete-Paving Studies.—The concrete-paving studies have had a similar purpose, i. e., to develop precisely the reasons why production so commonly fails to reach rates theoretically attainable. The observations made have clearly established these reasons, and the bureau has induced a number of contractors to make the changes in operating methods shown to be necessary with the most striking results.

In one case production under the contractor's management had averaged 36 lin. ft. of pavement an hour and about 180 ft. a day. As a result of suggestions made by the bureau's engineers production rose steadily during the test period of about a month to an average of 62.5 ft. an hour attained during the last nine days and the daily production increased even more sharply as a result of the elimination of heavy time losses which had the effect of increasing the length of the working day. The effect of this improvement was to reduce the labor cost from $0.457 per sq. yd., which had been the average cost to the contractor, to $0.203 per sq. yd.

On another project the contractor's production had averaged 64 ft. an hour and 486 ft. a day. The suggestions made by the bureau's representative raised the output to a 7-day average of 97 ft. an hour and a maximum of 101 ft. for 12½ hours, a day's run of 1,263 ft. In this case labor had cost the contractor $0.207 per sq. yd. of pavement laid as against a cost of $0.128 per sq. yd. for the last week of the test period. Under the contractor's management 35,743 sq. yd. were laid in slightly over two months, while during the last week of the test period 10,096 sq. yd. were laid, and this in spite of the fact that of the six working days, one-half day was lost on account of rain and another half day at the end of the period by the completion of the pavement to be laid at noon of the last day.

Recent Highway Research Development

Work of Highway Research Board Summarized in Paper Presented Nov. 20 at 11th Annual Meeting of the American Association of State Highway Officials

By CHARLES M. UPHAM

Director, Highway Research Board of National Research Council

In the development of every science there are certain periods which stand out as epochs in the progress of that science. Just as the Bates Road, the Pittsburgh (Calif.) and the Arlington tests were distinct developments in the science of highway construction, so the investigations financed by industrial concerns and conducted under the auspices of the highway research board of the national research council mark a new era in highway research.

There are now several of these studies under way, and in every case they are concerned with a moot problem in highway work which no state highway department or industrial organization would ordinarily conduct alone. The studies undertaken are national in scope and the highway research board offers auspices under which such work may be carried on that is scientific in character and impartial in its findings. It is gratifying to note that the board has secured the fullest co-operation from the state highway departments and other organizations engaged in highway research in the prosecution of the studies it now has under way.

Economic Value of Steel Reinforcement.—The first such study to be undertaken by the board was that on the economic value of steel reinforcement in concrete roads. In connection with this work, careful field inspections have been made in every section of the country and information is now available which covers all conditions of service and is representative of every state in the Union. The final report on this investigation will be the most complete study of reinforced concrete roads ever undertaken. It is expected that as a result of this investigation, the matter of reinforcement in concrete roads will no longer be a moot question.

Another investigation being conducted under the auspices of the highway research board, and one which will be of utmost importance to the public for many years to come, is that on the development of earth roads. Although the title of this investigation appears to limit its scope, the object is to determine some type of road surface that will be low in first cost and maintenance and suitable for light traffic. Thus far, only the preliminary stages of this investigation have been made, but these show what has been done and what is now under way in attempts to solve this problem. Field inspections will soon be undertaken which will indicate further research needed in order that methods may be evolved which will, at comparatively small expense, put our secondary roads in proper condition to serve as feeders to our main highways.

Culvert Pipe Investigation.—Considerable interest has been shown by engineers in the culvert pipe investigation. By means of correlation of existing studies and by field inspections, it is hoped to determine the proper basis of comparison for evaluating the life, usefulness and economic value of different types of culverts and small drainage structures in use. Engineers will then have scientific data on which to base their decisions, thus replacing the uncertainty which now exists in the design of this important part of the highway.

The state highway departments have responded splendidly to the study of the urban highway finance problem also being conducted under the auspices of the highway research board. This investigation is of great interest and importance to the general public as well as to engineers, as it treats of the relation of the city dweller to rural highway finance and of the financial aspects of widening of city streets and of city traffic control. In addition to the studies enumerated, the board has been requested to undertake similar researches looking toward the solution of certain problems in highway engineering.

Reaching the Public.—The activities of the highway research board have not been confined solely to the solution of technical problems. In addition, considerable work has been done in acquainting the public at large with the economic value of highway research and the desirability and need for giving support to this type of work—both from the local, as well as the national standpoint. This has been carried on through radio addresses and by newspaper and technical articles. Plans are under way for developing this work to an even greater extent, as it is felt that the promotion of highway research can only continue as it has public support which is based upon

a knowledge of the sound economic value of this work.

In addition to its contact men from the state highway departments, the highway research board recently enlarged its sphere of activities by securing representatives from the universities and colleges throughout the United States. This makes possible not only a closer co-operation between the board and the universities conducting highway research, but also serves as a means of bringing to educational authorities and to engineering students information concerning the work being carried on throughout the country on highway research. Since these representatives have been named, there has been much evidence of a desire on the part of the universities to assist in the development of the highway research program and many requests have been received for information and guidance as to how they may co-operate in this important work.

Contacts with Latin America.—Another significant development has been the extension of contacts with the Latin American countries which are now developing programs of highway construction. The highway research board has felt that by giving to these organizations the benefits of accumulated highway research not only would this be of advantage to the cause of research in the United States, but it would serve to develop more fully our international relationships.

A recent development, which has been receiving a splendid reception from highway research workers, is the issuance by the board of a bulletin twice a month known as Highway Research News. The object of this publication has been to weld together highway research personnel throughout the country; acquaint research workers with what is going on in their particular field of work; encourage them to avail themselves of the services of the highway research board in connection with their studies; and incidentally to acquaint the public at large of the economic value and significance of highway research.

A policy which the highway research board hopes to put into full effect during the coming year is the employment of technical assistants to give full time to the work of research committees. It is well realized that committee members are very busy men and cannot devote the time necessary for the detail committee work.

A very enthusiastic reception has been accorded the summary bulletin which was issued by the highway research board, giving in concise form the principal facts of highway research which may be practically applied as presented at the last two annual meetings of the board. It has been found necessary to reprint the first issue of this bulletin, a total of 8,000 copies having been distributed. This would indicate that the summary bulletin is an outstanding contribution in the presentation of the findings of highway research to all persons engaged in this field.

During the past year considerable increase has been noted in the number of requests for information received by the board concerning many matters of highway research, thus indicating that the information service conducted as a part of the work of the board is really establishing this organization as a national clearing house for all matters pertaining to highway work.

Work of U. S. Bureau of Public Roads.—Another important development during the past year has been the summarization of highway research progress that is being made by the United States bureau of public roads and which is appearing in Public Roads, the research journal issued by that organization. These studies bring together the results of highway research in particular fields, thus giving the highway research worker a perspective of what has been done in that field and serving as an incentive for the continuation of further studies. Mention should also be made of the research done by the bureau in connection with highway construction operations, a subject of vital importance, and one which has long been neglected. These studies have revealed the reasons why production in highway building so commonly fails to reach levels theoretically possible.

Contacts with State Highway Department.—The contacts of the highway research board with the state highway departments show that they recognize that the results of highway research are of national rather than of local importance. The departments have evidenced a desire to avoid duplication of effort and a willingness to place into immediate practice research results from other states that may be adapted to their local conditions. The investigations by the highway research board have brought to light considerable material which would not otherwise have received the wide currency that will be given to it as a result of being included in one of these national studies.

The excellent spirit of co-operation shown by the state highway departments is evidence that the highway research board of the national research council is meeting a need among the states for a national agency to coordinate highway research throughout the country and to serve as a clearinghouse for all highway research matters.

Three Traffic Lanes to Speed Up Vehicles

A novel method is being tried in Division IV of the California Highway Department in an effort to bring about a more efficient use by traffic of the 36 ft. pavement on a portion of the Peninsula highway immediately adjacent to the city of San Mateo, San Mateo County. According to California Highways three traffic strips have been painted longitudinally with the pavement in the following manner:

One strip 4½ in. wide was painted down the center line of the pavement and two additional strips, with 9 ft. 6 in. clearance, on either side of the center line strip. All three strips were painted on the asphalt concrete surface which is slightly over 20 ft. wide, leaving the two 8 ft. strips of bare concrete shoulder on either side of the old pavement, or a total of 8 ft. 6 in. outside of the traffic strip. The width of lanes are, therefore, outside strips, 8 ft. 6 in.; and the two center lanes, 9 ft. 6 in.

Slow moving traffic is expected to confine itself to the outside lanes, leaving the central two lanes for the fast automobile traffic going in either direction. Local and state traffic officers assist in directing traffic in accordance with this plan.

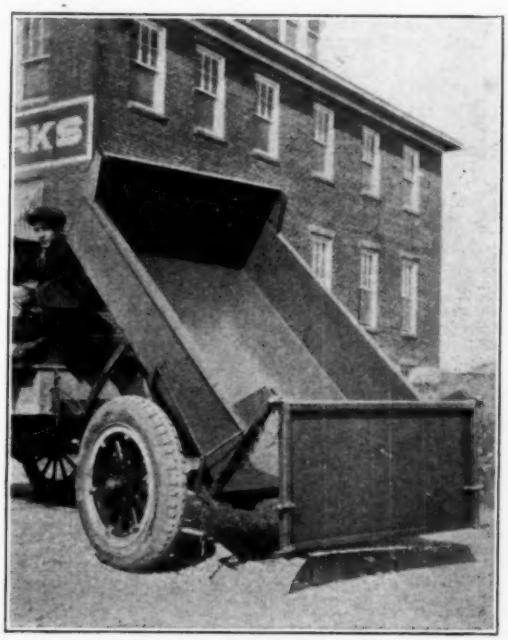
Freezing and Thawing Tests of Concrete

Attention has been attracted recently by failures of concrete which have been attributed to the inability of the aggregates used to resist repeated frost action without disintegration and consequent injury to the concrete. Certain laboratory tests have been proposed, notably the sodium sulphate and accelerated soundness tests, which attempt to predetermine this characteristic of the aggregate. It is thought, however, that laboratory test data obtained by means of this test should be correlated with actual freezing tests on the concrete in which the aggregates are incorporated before the results can be interpreted correctly.

For this purpose the U. S. Bureau of Public Roads now has under way a series of freezing and thawing tests on concrete in which various types and grades of coarse aggregate are used. The materials being studied include trap rock, several grades of limestone, including cherty limestone, limestone containing thin shale bands, etc., dolomites, soft sandstones, gravel ranging in quality from hard quartz to those containing relatively soft, easily disintegrated materials, an excess of flat pieces, shale, etc. Both heavy and lightweight blast furnace slags are also being investigated. The tests are being made on beams which are alternately to be frozen and thawed and then tested for modulus of rupture. It is believed that the results of these tests will clear up some doubtful points regarding the significance of the accelerated sodium sulphate soundness test and the value in general of certain types of materials as aggregate for concrete.

Steel Dump Bodies for Ford Trucks

An automatic gravity all steel dump body for Ford 1-ton trucks is a recent product of the New York Central Iron Works Co., Inc., Hagerstown, Md. The dump and return are operated entirely by foot pedal by the driver.



Quicktrip Steel Dump Body

The body is rigidly supported at 45 degrees by heavy steel "stiff legs," permitting use of batch partitions also spreading. The body has a length of 72 in. (94 in. with gate down), a width at rear of 49 in. and a depth at sides of 13½ in. at front and 21 in. at rear. Its capacity is 1 cu. yd. at sides, 42½ cu. ft. with straight side boards, and 57½ cu. ft. with flared sideboards. The body is made of 10-gauge steel plate, one piece, with no seams. The subframe is 3½ in. structural steel angles, hot riveted. The body can be installed on chassis in less than 30 minutes; no drilling is necessary.

New Trade Publications

The following trade publications of interest to highway officials, engineers and contractors have been issued recently. Copies of them can be obtained by addressing the firms mentioned:

Rock Asphalt Pavements.—An interesting booklet on natural rock asphalt has just been issued by the Natural Rock Asphalt Corp., Owensboro, Ky. It contains chapters on the geology and character of natural Kentucky rock asphalt, on methods of handling and laying this material and on the types of base, both old and new, which are used under rock asphalt wearing surfaces. Particular attention is given to resurfacing old roadways, and chapters also are included on maintenance of rock asphalt pavements and patching other types with natural Kentucky rock asphalt.

Expansion Joints.—A 68-page book has been brought out by the Servicised Products Corp., 6051 West 65th St., Chicago, containing engineering data relating to expansion joints, center strips, marking paints, and other products of the company. The book contains a general discussion of joints and their composition reports from engineering testing laboratories, and specifications together with chapters on installation methods.

Clam Shell and Orange Peel Buckets.—A new bulletin illustrating and describing the uses of its buckets in road, street and sewer work is just issued by the Hayward Co., 38-50 Church St., New York.

Road Building Machinery.—The Good Roads Machinery Co., Kennett Square, Pa., has brought out a broadside illustrating and describing its complete line of road building machinery.

Portable Air Compressors.—A bulletin devoted to its improved type of portable compressor for the Fordson has just been issued by the Curtis Pneumatic Machinery Co., 1681 Kienlen Ave., Cincinnati, O. The various features of the outfit are illustrated and described and specifications are given. Information also is included on operation, on capacities of various tools and the cost of their operation.

Timken Bearings and Foote Pavers.—An interesting brochure dealing with the use of Timken bearings in its pavers has been issued by the Foote Co., Inc., Nunda, N. Y. The bearings are described and their applications in the paver are illustrated and described.

Gasoline Locomotives.—The Milwaukee Locomotive Manufacturing Co., Milwaukee, Wis., has just issued a new catalog illustrating and describing its complete line of gasoline locomotives, now built in size from 4½ to 18 tons. Details of the various features are given, together with tables of condensed specifications for each type of locomotive.

Bucket Loaders in Paving.—A bulletin dealing with the use of its bucket loader in feeding the paver from advance storage piles has just been issued by the George Haiss Mfg Co., Inc., 143rd St. and Canal Place, New York. It contains information on comparative costs, diagrams of paving layouts, and diagrams for finding number of trucks required. In addition information is given regarding several jobs on which the method was used.

Concrete Mixers.—The Chain Belt Co., 731 Park St., Milwaukee, Wis., has brought out a catalog devoted to its Rex 7-S and Rex 5-S Mixers. The various features of these mixers are illustrated and described and tables of capacities, and dimension charts are given.

Industrial Notes

The Griscom-Russell Co. has removed its general offices to the new Murray Hill Bldg., 285 Madison Ave., at 40th St., New York City.

The Mundy Sales Corporation, 30 Church St., New York City, has been organized to market and distribute the hoisting equipment manufactured by the J. S. Mundy Hoisting Engine Co., whose main office and factories are located in Newark, N. J. The Mundy Sales Corporation will direct the activities of the exclusive sales agents throughout the United States.

The Bryan Harvester Co., Peru, Ind., has changed its name to the Bryan Steam Corporation. This change is in name only and has been made to indicate more clearly the nature of the company's products and does not affect the personnel of the organization.

The Timken Roller Bearing Co., Canton, O., announces the appointment of Ernest Wooler as chief engineer. For the past year Mr. Wooler held the position of automotive engineer. His present position puts him in full charge of all automotive, industrial, experimental and service engineering. Other changes in the executive personnel of The Timken Roller Bearing Co. include the promotion of J. W. Spray to the position of manager of sales, automotive division. E. W. Austin has been promoted to the position of assistant manager of sales, automotive division. R. W. Ballentine has also been made assistant manager of sales, automotive division. Peter C. Poss has been made assistant advertising manager.

Harnischfeger Sales Corporation, distributor for Harnischfeger Corporation announces the location of a branch office at 808 Guaranty Bldg., Indianapolis, Ind. J. H. Enochs is district manager, in charge of this office.

Death of George Haiss.—George Haiss, President of the George Haiss Manufacturing Co., New York, died Jan. 11, of apoplexy. He was born at Bethel, N. Y., April 22, 1859. In 1892 Mr. Haiss organized the George Haiss Mfg Co., manufacturers of material handling machinery. Among Mr. Haiss's better known inventions and patents are: Clam shell buckets, coal hoisting towers, continuous elevator and bucket conveyors, belt conveyors and truck loaders. He was also president of the Haiss Realty Co., New York. He is survived by his widow, three sons and daughter.

Climax Sales Conference.—The second annual sales conference of the Climax Engineering Co., Clinton, Ia., was held at Clinton, Jan. 16, 1926. About 50 manufacturers and dealers of road-making machinery attended the gathering. Friday night following the close of the Road Show, two Pullmans filled with Climax guests and personally conducted by President George W. Dulany, Jr., pulled out of the Northwestern Station, Chicago. At 7:30 the Pullmans were met in Clinton by a fleet of automobiles. The visitors were conducted to the Lafayette Hotel for breakfast, after which the party adjourned to the Climax Foundry, where the morning heat was being poured. From here the visitors were conducted to the main shops of the company. At twelve the visitors gathered at the office, where luncheon was served. Later on a business meeting and conference was held under the chairmanship of President Gorge W. Dulany, Jr. The program followed the development of the gasoline engine, from its design to sale. Talks were made by executives, and members of the Climax staff were presented to the visitors. Among those who spoke were: H. H. Waters, Chief Engineer, who discussed the "Development of the Gasoline Engine." H. E. Riggs, Production Manager, who spoke on behalf of the shop, L. Dunlevy, sales Manager, who reviewed his sales organization. R. C. Rowan, General Manager, on "Management." Norman McCarty, Diesel Engineer, on "Diesel Engine Practice." R. L. Alexander, Refrigeration Manager, on the "Climax Refrigerating Units." C. A. Tupper, President International Trade Press, Inc., on "Foreign Trade." C. E. Bregenzer, General Manager Roads and Streets Magazine, on "Trade Paper Advertising." Fred Young, President Racine Radiator Co., on "Radiators." P. H. Batten, President Twin Disc Clutch Co., on "Clutches." Walter Smith, Rogers & Smith Advertising Agency, on "Climax Advertising." After the business meeting, the convention adjourned until 7:30, when a banquet was held at the Clinton Boat Club.

Meetings and Conventions

Road School.—Fifteenth annual road school for county and state highway workers will be held in the State Capitol, Madison, Wis., Feb. 8 to 12, 1926.

National Industrial Conference Board.—Meeting, New York City, Feb. 18.

American Sand Association.—Meeting Cleveland, Ohio, Feb. 9.

National Association of Builders Exchanges and National Building Exposition.—Annual convention and exposition at the Coliseum, Oklahoma City, Oklahoma, week of February 22, 1926. J. B. Landers, Secy.-Manager, Chamber of Commerce Bldg., Oklahoma City.

American Concrete Pipe Association.—Annual Convention, Sherman Hotel, Chicago, Ill., Feb. 22 and 23.

American Concrete Institute.—Annual convention, The Drake Hotel, Chicago, Ill., Feb. 23-26. Harvey Whipple, Sec'y., 2970 West Grand Blvd., Detroit Mich.

Heating & Ventilating Exposition.—Exposition, Madison Square Garden, New York City, March 17-23. E. P. Frenz, Secy., Hotel McAlpin, New York City.

American Society for Testing Materials.—Convention Haddon Hall, Atlantic City, N. J., June 21-25. C. L. Warwick, Secy., 1315 Spruce St., Philadelphia, Pa.

American Society of Mechanical Engineers.—Spring convention, San Francisco, Calif., June 28-30. Calvin W. Rice, Secy., 29 West 39th St., New York City.